A STUDY OF THE VALUE OF PROJECT STAGE-GATES WITHIN A NUCLEAR POWER PLANT

By

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TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

TABLE OF ACRONYMS

CRA	Concept Release Approval
CBS	Cost Breakdown Structure
CoE	Centre of Excellence
DCF	Delegation Consent Form
DRA	Definition Release Approval
ERA	Execution Release Approval
FRA	Finalisation Release Approval
HOA	Hand-Over Approval
IC	Investment Committee
ISO	International Organisation for Standardisation
NDP	New Product Development
NPM	Nuclear Project Management
URS	User Requirement Specification
PLCM	Project Life Cycle Model
PMO	Project Management Office
PMP	Project Management Plan
PMBOK	Project Management Body of Knowledge
PWR	Pressurised Water Reactor
QADP	Quality Assurance Data Package
SALTO	Safe Aspect of Long Term Operation
SOW	Statement of Work
WANO	World Association of Nuclear Operators

ABSTRACT

Background: Project Management has become a key activity in most organisations. Organisations are investing increasing resources in projects such as new product development, process improvement, or building new services. This research study has been conducted at a nuclear power plant and it explores the value of project stage-gates within a nuclear power plant.

Research Purpose: To identify areas for improvement within the stage-gate review process within Nuclear Project Management.

Research Objectives: The research study has considered the following research objectives: determining stage-gate review process drivers; establishing the value obtained from the stage-gate review process; determining the impact of not conducting PLCM stage-gate reviews.

Research Methodology: A qualitative approach was pursued with a survey questionnaire administered to sample and follow up interviews conducted with the same sample population. A questionnaire and interviews have been conducted with Project Managers (PMs) of the power plant to collect qualitative information about the stage-gate review process. Data has been analysed, interpreted and recommendations have been made.

Research Findings: The research findings show that there is a general understanding of the stage-gate review definition; performing stage-gate reviews; purpose of the stage-gate and stage-gate drivers. However, this research study revealed that there are some gaps and little understanding regarding the benefits of the stage-gate review process; impact of not conducting stage-gate reviews; stage-gate effectiveness and stage-gate monitoring. Therefore, there are various factors that need to be rectified to enhance the effective implementation of the stage-gate review process.

Research Limitations: The research study focused on the projects run within the nuclear projects department, in order to simplify the data collection process**.** Strategic information that was deemed as sensitive or confidential could not be revealed explicitly during the course of data gathering and therefore inferences had to be made.

Keywords: stage-gate review process, PLCM, project management, gate keepers.

1. INTRODUCTION

1.1.Background Study

South Africa is the only country in the African Continent that uses nuclear energy to generate electricity. The nuclear power plant is located in Koeberg, which is situated 30 km north of the Cape Town CBD along the western seaboard. The nuclear power plant plays a vital role in ensuring a reliable supply of electricity to the Western Cape Province. It has operated safely for more than 30 years and has a further active life of more than 40 years. The plant has a pressurised water reactor (PWR) design which uses seawater to cool the condensers on the secondary side. It has two nuclear reactors that supply 1 800 MW, or 6 to 7% of South Africa's electricity needs. The nuclear power plant has produced more than 81 000 million KWh of electricity since 1984 when it was first commissioned, using seven and a half tonnes of Uranium in the process. Koeberg makes a small contribution to the electricity mix to South Africa. For instance, in 1998 the Koeberg generated 13,6bKWh (billion Kilowatt hours) of electricity, accounting for about 7 % of the country's total electricity generation (Eskom, 2013).

One of the important contributions to the successful operation of the Koeberg Operating Unit is the steady implementation of modifications. This entails the supply of spare parts and award and execution of contracts in accordance with the relevant nuclear standards and specifications. Modification refers to a permanent or temporary change, deletion or addition to any plant system, equipment or structures systems, or components or part thereof, or changes to operating parameters that affect the design or operation of a plant or building (Cooper *et al.*, 2002; Eskom, 2013). This includes the replacement of plant components with equivalent components.

The nuclear industry adheres to processes and procedures to ensure that the plant operate safely and in a reliable manner. It is expected that modifications and projects that are implemented are of high quality. Furthermore, modifications and projects are implemented in accordance with correct nuclear industry codes

and standards, specifications, procedures and processes from the initiation phase until the close out phase.

1.2.Background to the Research Problem

The nuclear power plant has embarked on the extension of the plant life which is known as Safe Aspect of Long Term Operation (SALTO), current studies are being performed and the plan is to extend the operation to 60 years. This means major components should be replaced. To comply with the international standards, stage-gate reviews should be taken into consideration when introducing major changes to the implementation of modifications and projects. In addition to the above statement, traceability, lessons learnt and nuclear safety plays a crucial role in the implementation of modifications and projects.

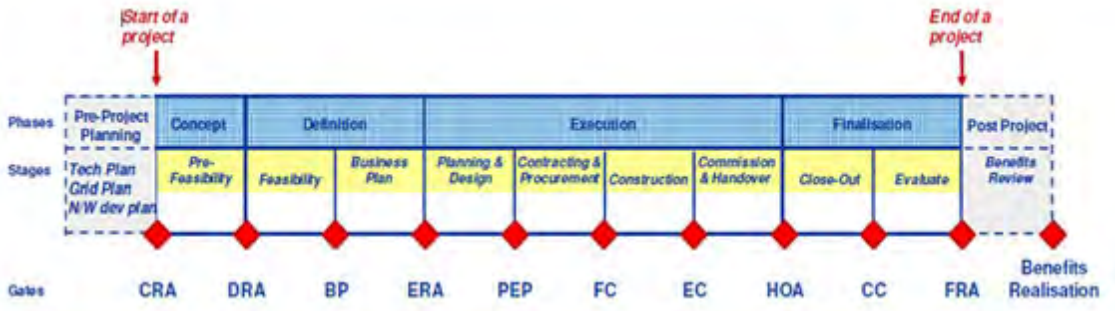
The nuclear power plant has demonstrated its ability to operate reliably, safely and efficiently. This research aims at establishing the value that is obtained from applying the stage-gate review process and also determining the impact of not conducting Project Life Cycle Model (PLCM) stage-gate reviews. The research was conducted on projects that have been recently implemented at the plant. Projects that were implemented prior to the implementation of the stage gate process will be referred to as group A. Projects that were implemented using the stage-gate process will be referred to as group B projects. This research was also conducted to identify areas for improvement.

1.3.Project Life Cycle Management (PLCM)

The PLCM framework is a comprehensive approach, it is used as a basis for sustainable project management and it can be easily adapted to various industries. In the PLCM, both deliverables and project performance are reviewed at the end of each project phase (Claasen *et al.*, 2005).

The standard nuclear power plant PLCM consists of four phases and nine sub-phases, refer to figure 1 below. (Eskom, 2013). Each phase has a stage-gate which is applicable to the pre-defined nuclear power plant governance and Divisional management structures authorised to allocate additional resources,

approve additional financial investment and take on additional risk for projects. The four phases of the standard nuclear power plant project life cycle are: Concept Phase, Definition Phase, Execution Phase and Finalisation Phase and the five phase gates of the standard nuclear power plant project life cycle are: Concept Release Approval (CRA), Definition Release Approval (DRA), Execution Release Approval (ERA), Hand-Over Approval (HOA) and Finalisation Release Approval (FRA) (Eskom, 2013). The nine sub-phases are: Pre-feasibility, feasibility, business plan, planning design, contracting and procurement, construction, commission and handover, close-out and project evaluation.



Key		
1	CRA	Concept Release Approval.
2	DRA	Definition Release Approval.
3	BP	Bankable Project.
4	ERA	Execution Release Approval.
5	PEP	Project Execution Plan

Key		
6	FC	Financial Closure
7	EC	Execution Completion
8	HOA	Hand Over Approval
9	CC	Contract Close
10	FRA	Finalisation Release Approval

Figure 1: Standard nuclear power plant PLCM (Eskom, 2013: 10)

1.4.The nuclear power plant stage gate review policy or procedure

The high level document that is used is the standard project life cycle model set out in a policy document (Eskom, 2013). The PLCM is governed by this standard in the whole organisation and it consists of four phases and nine sub-phases, refer to figure 1 above. The requirements of this standard have been cascaded down to the Koeberg Operating Unit level. The Koeberg Operating Unit makes use of the project management process for modifications procedure which Project Managers adhere to when managing projects. This procedure involves

various departments including; Work Control, Operations Support, Training, Procurement, Finance, Engineering Programmes. The stage-gate process has also been incorporated into the project management process for modifications procedures (Eskom, 2013).

1.5.The level of stage-gate adherence or compliance

The project management process for modifications is adhered to when managing all projects (Eskom, 2013). However, the following problems exist:

- **Changes from Corporate:** The standard project life cycle model policy has changed a number of times and this process appears to continue and this might cause delays in the project
- **Changes on the stage-gate templates:** The stage-gate templates have changed a number of times and this might cause delays in the project and also discourages Project Managers from using these templates
- **Budget constraints:** Projects are prioritised according to budget and also risk to the plant system therefore changes to the stage-gate review process, or/and modification process affect project progress and project milestones (Eskom, 2013).

1.6.Stage-gate System

Stage-gate systems are defined as "*both a conceptual and an operational model for moving a new product from idea to launch and beyond"* (Cooper, 1990: 44). Subsystems are essential for managing the product development process to improve effectiveness and efficiency. The stage-gate process at Koeberg is divided into five stages and five gates; in addition there is a discovery and post launch review. Stage-gates play a vital role and they should be mapped out, with clear purpose and goals that are well defined and proficiently executed (Cooper, 2008a):

- Each stage-gate is designed to gather information to reduce key project uncertainties and risks; the information requirements thus define the purpose of each of the stages in the process
- The activities within stages are undertaken by a team of people from different functional areas within the organisation

- Each stage-gate review is cross functional (Cooper, 2008a)

Each project stage has a quality control check point, called a “gate”, defined as a set of quality criteria and deliverables which are specified at each gate that a project must achieve before it can proceed to the next stage. The project stages focus on the work that needs to be done and the gates ensure that quality requirements are met by the project (Cooper, 1990).

Each project phase is followed by a stage-gate review where Go/Kill decisions are made to continue to invest in the project. Each stage-gate process requires its own inputs and outputs. These are provided by the Project Manager and consist of specified deliverables that meet stated criteria at a given date. Senior Managers are considered to be the “gate keepers” and have the authority to approve resources needed by the project in order to move to the next phase. The role of the stage-gate includes: “*review of the quality of work to date, assessment of the quality of the project and approval of the action plan for the next stage”* (Cooper, 1990: 46).

Furthermore, stage-gates function as quality control check points, Go/Kill decisions points, and direct the path forward for the next stage of the project, (check wording). Stage-gates comprise of the following:

- **Deliverables:** This requires the Project Manager and team to provide the specified deliverables and meet the stated criteria. These deliverables are visible and are specified in the output of the previous gate
- **Criteria against which the project is judged**: These include meeting project criteria which are used to prioritize projects for instance quality requirements, technical requirements and financial requirements.
- **Outputs**: This includes a decision to Go ahead/Kill/Hold/Recycle the project. An approved action plan, timelines and resources committed, together with a list of deliverables and dates for the next gate are agreed to.

The PLCM standard is applicable to the governance of all projects of a capital nature within the nuclear power plant. All Projects are required to pass through decision control gates for investment and implementation decisions undertaken within the nuclear power plant. However, there is a problem with the effective implementation of the stage-gate system in the project management arena. This research project aims at evaluating the impact of not conducting stage-gate reviews, identifying the value obtained from the stage-gate reviews and establishing who is responsible for stage-gate effective implementation.

1.7.Problem Statement

The research problem is:

The stage-gate review process is not used by some projects that are mandated to do so.

1.8.The Research Question

What value does the stage-gate review process add to projects in the nuclear power plant?

This research study aims at:

- Identifying areas for improvement
- Evaluating the impact of not conducting stage-gate reviews
- Identifying the value obtained from the stage-gate reviews
- Establishing who is responsible for stage-gate effective implementation.

1.8.1. Sub questions

The sub-questions to be researched in support of the research question are as follows:

- Who drives the stage-gate review process?
- What value is obtained from the stage-gate review process?
- Who gains value from the stage-gate review process?
- What is the impact of not conducting PLCM stage-gate reviews?

1.8.2. The Research Objectives

The research objectives to be considered in this research project are the following:

- Determine who drives the stage-gate review process
- Establish what value is obtained from the stage-gate review process
- Determine who gains from the stage-gate review process
- Determine the impact of not conducting PLCM stage-gate reviews.

1.8.3. The Research Methodology

A qualitative approach was pursued with a survey questionnaire administered to sample and follow up interviews conducted within the same sample population. Data was analysed, interpreted and recommendations were made.

1.8.4. Limitations

The following limitations are assumed for the research study:

- Even though the project management processes are used in the whole organisation, the research will focus only upon the projects run within the nuclear projects department, in order to simplify the data collection process
- Strategic information that was deemed as sensitive or confidential could not be revealed explicitly during the course of data gathering and therefore inferences had to be made.

Research Aims	Research Questions	Research Objectives	Research Methodology
Establishing who is responsible for stage-gate effective implementation	Who drives the stage-gate review process?	Determine who drives the stage-gate review process	. A Qualitative methodology has been used in this research study
Establishing the value of the stage-gate process	What value is obtained from the stage-gate review process?	Establish what value is obtained from the stage-gate review process	A Qualitative methodology has been used in this research study
Identifying the value obtained from the stage-gate reviews	Who gains value from the stage-gate review process?	Determine who gains from the stage-gate review process	A questionnaire and interviews have been conducted
Evaluating the impact of not conducting stage-gate reviews and Identifying areas for improvement	What is the impact of not conducting PLCM stage-gate reviews?	Determine the impact of not conducting PLCM stage-gate reviews	

Table 1: Research aims, research objectives and research questions

1.8.5. Structure of the Research Report

Chapter One: Introduction

This chapter encompasses introductory statements as well as a background to the study and the problem statement is presented. The subsequent research questions, aims, objectives, the research methodology, and limitations are also introduced and described.

Chapter Two: Literature review

This chapter will provide the literature review and documentation analysis on the following topics: PLCM, stage-gate system, the purpose of a stage-gate system and the advantages and disadvantages of a stage-gate system.

Chapter Three: Research Methodology

This chapter describes the research methodology proposed and selected for the study; which will be qualitative in nature. It provides the following investigation approach: Case study and structured interviews with selected Project Managers.

Chapter Four: Analysis of data

This chapter allows for the analysis of the gathered data and presents a discussion of the findings.

Chapter Five: Conclusions and recommendations

The concluding chapter contains the conclusions drawn from the empirical data. Based on these conclusions, a number of recommendations will be proposed and further research is highlighted.

2. LITERATURE REVIEW

2.1. Introduction

This chapter introduces the idea of the stage-gate integrated into the project life cycle management (PLCM) model. The primary driver for this innovation or development was practiced in the new product development sector by Cooper (Cooper, 1990). The chapter goes on to examine other literature about others sector and finally explores the reported advantages of utilising a stage-gate system.

This chapter will cover the following key points: project management definition, PLCM, stage-gate system, advantages of the stage-gate system, the purpose of a stage-gate system, checklist definition, disadvantages of the stage-gate system, difficulties faced by organisations using a stage-gate system and benefits of the stage-gate system.

2.2. Project Management Defined

Project Management has become a key activity in most organisations. Organisations are investing increasing resources in projects such as new product development, process improvement, or building new services.

Kerzner (2006: 2), defines a project as "*a specific objective to be completed within certain specifications, with defined start and end dates, have funding limits (if applicable), and which consume resources (i.e. money, people, equipment)*".

Project management is described as "*the application of knowledge, skills, tools and techniques for the project activities to meet the project requirements. This application of knowledge requires two kinds of processes: project management process and product oriented process in order to manage the project effectively*" PMBOK (2013: 47).

"*From a value management perspective a project is an investment by an organization on a temporary activity to achieve a core business objective within a*

programmed time that returns added value to the business activity of the organization" (Kelly, 2007: 435).

Project management (PM) can be used as a means of identifying, defining, monitoring and delivering business benefits as a result of development opportunity (Remenyi and Sherwood-Smith, 1998).

Project management is used to manage the stages between the gates and it can shorten the time between the gates (Kerzner, 2006).

It has been suggested that a "*good methodology for project management will provide checklists, forms, guidelines to ensure that critical steps are incorporated*" (Kerzner, 2006: 64). The stage-gate process forms part of the project management process in a variety of settings. In the past stage-gate was used mainly for new product development (Kerzner, 2006).

2.3. Project Life Cycle Model (PLCM)

The project life cycle is effectively the cornerstone of project management which represents a standardized model of the phases of a project. In order to achieve the desired objective of a project one must go through a specific process which is called the project life cycle (Hodgson, 2002).

The project life cycle has been described as "*a logical sequence of activities required to achieve the goals or objectives of a project irrespective of its scope or complex nature*" Zwane *et al.* (2014: 152).

When an idea begins to be pursued as a project, there are several phases that the project must go through before it is completed or until the product is launched. The delivery process consists of various phases of the Project Life Cycle Model (PLCM) such as: the review opportunity phase; pre-project planning phase; concept phase; definition phase; execution phase; finalization phase and the benefit realization phase (Eskom, 2013).

The PLCM is defined as "*the sum of all activities needed to define, develop, implement, build, operate, service and phase out a product or solution and its related variants"* (Ebert, 2005: 1). The PLCM is regarded as a stage-gate model as one of the fundamental processes for strategic solutions and decisions (Cooper *et al.*, 2001). The PLCM is a "*project management methodology that has several phases and stage-gates that can be made adaptable to the size of an organization as well as to technical and business practices*" (Nicholas and Steyn, 2012: 555). Projects vary with regard to their size, complexity, resource needs, and risks (Nicholas and Steyn, 2012). Furthermore, the project life cycle provides the structure and approach for delivering the required outputs. There are many life cycles used and the choice depends on the nature of the organisation (Nicholas and Steyn, 2012).

2.4. The Cooper PLCM Stage-gate Model

The stage-gate model has been emerged from the new product development sector and has been extensively described by Cooper. A stage-gate system involves from four to seven stages, termed phases in this document and stage-gates depending on the organisation (Cooper, 1990). Figure 2 below illustrates the 5 stages and 5 gates of (Cooper, 1990) stage gate model.

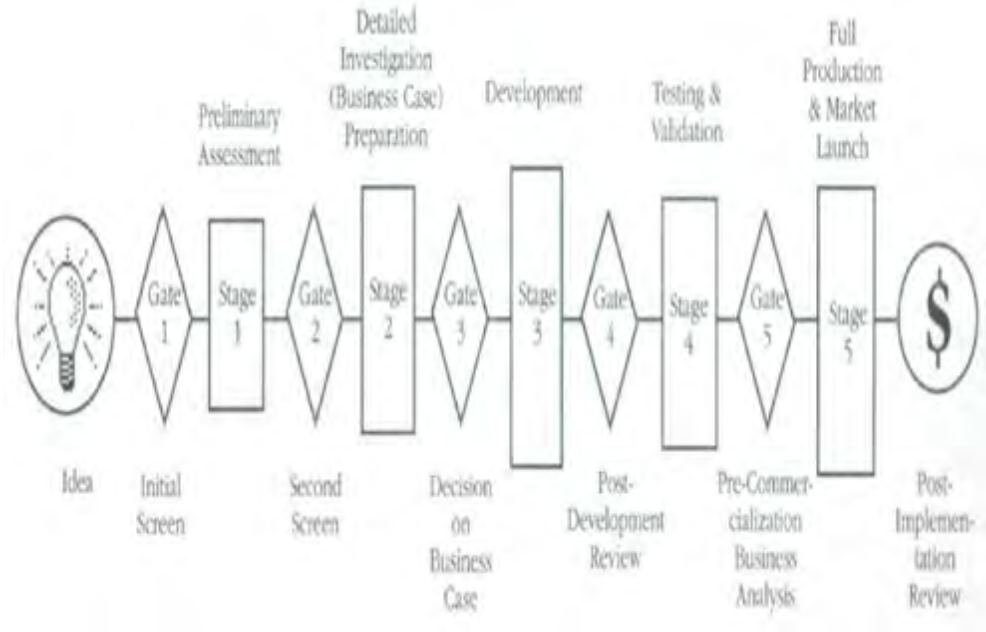


Figure 2: Cooper Stage-gate Model (Source: (Cooper, 1990: 46)

The entrance to each stage is known as a stage-gate and the process is controlled by these stage-gates. Each gate is characterized by its own inputs and outputs (Tomas *et al.*, 2011). The inputs are the deliverables that the Project Manager must bring to the gate. The outputs are the decisions at the gate, typically a Go/Kill/Hold/Recycle decision, and the approval of an action plan for the next stage. Senior managers act as "gatekeepers", and they manage the stage-gates and they have the authority to approve the use of resources needed by the project. More importantly, gatekeepers have more and broader experience and bring useful insights to the project (Cooper, 1990).

Each stage is described below:

2.4.1. Pre-project planning phase

- **Idea:** Whenever a new idea arises, a new product initiation process commences (Cooper, 1990)
- **Initial Screen:** Resources are committed to the project. The screening phase is based on the criteria drawn from the business objectives of the organisation. The criteria specifically include: feasibility of the project, size of the project, how the project is aligned with the business strategy, advantages of the project and contribution to the core business and market attractiveness. Checklists or scoring model are normally used to prioritise the projects in the initial screening phase (Cooper, 1990).

2.4.2. Concept Phase

- **Preliminary Assessment:** The objective of the preliminary assessment is to determine the technical and market potential merits of the proposal. A market assessment has to be conducted both on technical and market aspects of the proposed product. The assessment aims to determine the size of the market, market potential and acceptability. This assessment is conducted at a low cost and in a limited time so that the project can be re-assessed at next stage (Cooper, 1990).
- **Second Screen:** The project is re-evaluated with the new information obtained in the preliminary assessment. In this stage, the project financial returns are analysed. The criteria set in the preliminary assessment must be

met. Checklists or scoring models are used to assist in decision making. If the decision is Go, the project moves into next stage (Cooper, 1990).

2.4.3. Definition Phase

- **Definition:** This stage aims at verifying attractiveness of the project before expenditure. At this stage market research studies are conducted to determine customer requirements, competitive analysis and also define the winning new product (Cooper, 1990)
- **Decision on Business Case:** This is the final stage of the project at which it can be stopped before major funds and resources is committed. A detailed financial assessment is conducted on the feasible option to accept resource spending commitment (Cooper, 1990). The decision is taken based on the following aspects; the project definition, target market definition, project objectives, product or project specifications and project development strategy (Cooper, 1990).

2.4.4. Execution Phase

- **Development:** This stage involves product development with detailed testing, marketing and operations plans. An updated financial analysis is performed and all issues have to be resolved (Cooper, 1990)
- **Post development review:** This process monitors and controls the progress of the project to ensure work has been completed (Cooper, 1990).

2.4.5. Close out Phase

- **Validation:** This is the process of testing and verifying the validity of the project and product through customer acceptance and the operation process (Cooper, 1990)
- **Pre-commercialisation decision:** This stage focuses on the quality of activities and the results of validation stage. Financial projections which play a key role are reviewed in decision making. The operations and marketing plans are developed, reviewed and approved to start production (Cooper, 1990).

2.4.6. Post Project Phase

- **Commercialisation:** This stage involves the implementation of both operational and marketing plans for the project (Cooper, 1990).

- **Post Implementation Review:** In this stage, the project is terminated and the project team is disbanded. The project outcome becomes a regular product of the organisation's business. The project and product performance are reviewed based on profits, revenues, costs, expenditures and timings. The post project audit is conducted to determine project strengths, weakness and lessons learnt (Cooper, 1990).

Furthermore in all the stages (Cooper, 1990: 46) states the role of senior managers is to:

- Review the quality of the inputs or deliverables
- Assess the quality of the project from an economic and business standpoint, resulting in a Go/Kill/Hold/Recycle decision
- Assist the project leader chart the project's path
- Approve the action plan for the next stage (in the event of a Go decision) and allocation of the necessary resources (Cooper, 1990)
- Make Go/Kill decisions on the projects and also commit resources needed in the project (Cooper *et al.*, 2002: 4)

It has been suggested that the following rules of engagement are (Cooper *et al.*, 2002: 4), in Figure 3

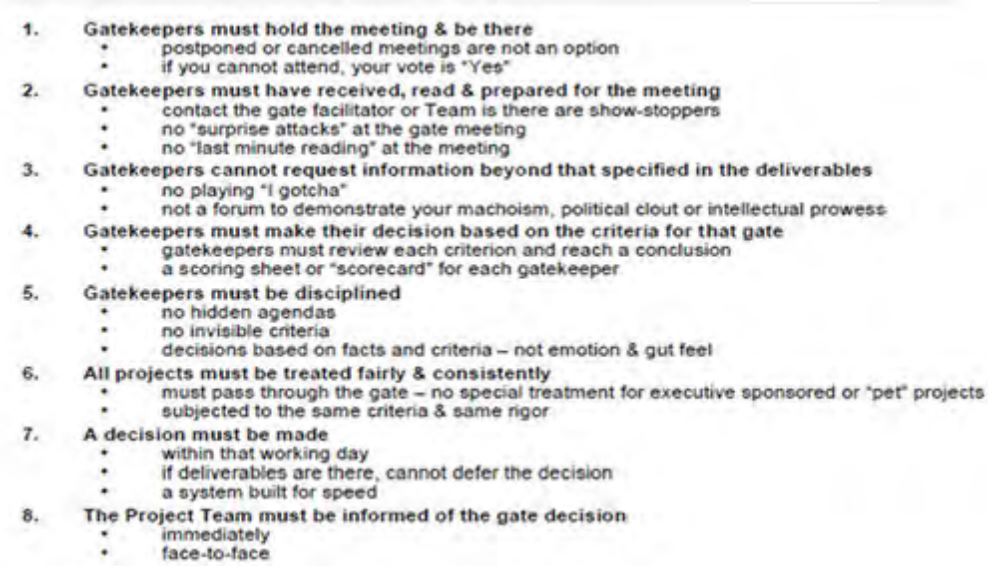


Figure 3: Cooper Stage-gate Model (Source: Cooper et al. (2002: 4)

The role of the project leader is:

- To drive the project from stage to stage and gate to gate
- To be aware of what inputs are required to "pass" the next gate and

- To organize the team to meet the input requirements of the upcoming gate (Cooper, 1990).

Stage number and name	Stage description	Review gate number and name	Review gate description
Stage 1. Preliminary concept development	Identification of the need and generation of a concept accompanied by a specification and economic justification (Wheelwright and Clark, 1992)	Gate 1. Preliminary concept review	The concept is reviewed in respect to the mission and capability of the organisation and the orientation of the market itself. This is to ensure that the concept is distinctive and complementary to the already existing capabilities of the organisation
Stage 2. Design and development	The design phase can be split into two sub-phases,varying in level of design *Initial design phase.* A geometric scheme of the product with a functional specification of each major sub-system and some initial process plans will be developed *Firm-up design phase.* A complete specification of geometry, materials, process plans and all unique parts in production will be produced	Gate 2. Design and development review	A decision is made as to whether to progress into detailed design for manufacture
Stage 3. Validation	Validation is a process of testing the strategies implied in the design to reduce risk and maximise expected benefit. It can potentially lead to increased quality of the product (Cooper, 1994). The initial validation stage can be early testing of prototypes, which may be made up of production "intent" parts. After initial testing there is further prototype testing, with supplied parts	Gate 3. Product launch review	The final review prior to launch of the product into the market, to ensure that the product is fit for purpose
Stage 4. In-service product support	When the product is launched, manufacturing is ramped up and the product is monitored in service	Gate 4. Product support review	Periodic reviews take place within the service life of the product to monitor the product's performance

Table 2: Stage-gate and review description: Source (Phillips *et al.*, 1999: 292)

2.4.7. Description of a generic stage-gate system

The description below is from one of the available sources describing a generic stage-gate system. This report discusses the following PLCM stage-gate models:

PLCM consists of the following phases: conception, definition and execution. The PLCM methodology also focuses on *"what happens before and after the project"* (Nicholas and Steyn, 2012: 556). "*Each phase deliverable is reviewed and accepted by the client, project sponsor, Project Manager and project champion in order to proceed with the next phase*" (Nicholas and Steyn, 2012: 557). A typical PLCM model is shown in Figure 4

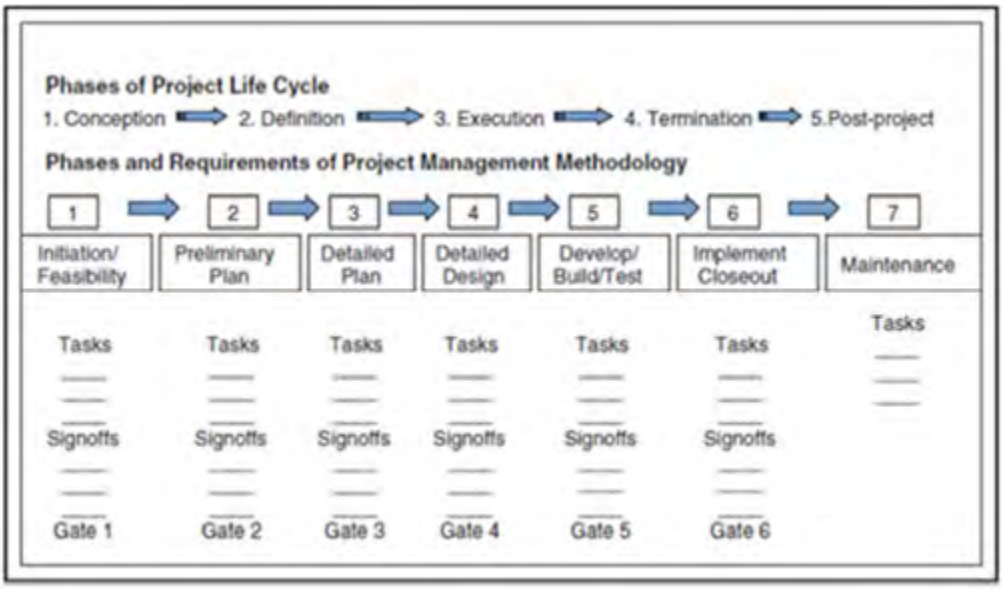


Figure 4: PLCM Stage-gate Model (Source: Nicholas and Steyn (2012: 555)

2.4.8. Conception Phase

Every project is undertaken to solve a problem. Therefore, recognition and acceptance of a problem is vital to resolve the problem (Kerzner, 2006; Nicholas and Steyn, 2012). During this phase the most significant sources of conflict are priorities, schedules, administrative procedures and labour (Nicholas and Steyn, 2012).

The conception phase consists of two stages (Nicholas and Steyn, 2012). The first stage, project initiation establishes a need or problem that needs to be investigated. The second phase, project feasibility which emphasis on the formulation of alternative solution selection of feasible solutions (Nicholas and Steyn, 2012).

2.4.9. Definition Phase

In this phase, the contractor begins a detailed analysis of the project concept and project requirements are defined and must meet the customer's needs. A comprehensive project plan is compiled. It defines activities, schedules, budgets and resources to design, build and implement the project (Nicholas and Steyn, 2012). The project has to be defined to implement the feasible option to resolve the problem. Project definition includes: developing project team, deriving project objectives, detailed project plan, project specifications, project scope, and verifying user requirement specifications (URS) (Nicholas and Steyn, 2012).

2.4.10. Execution Phase

This phase includes the design stages; build and implementation refer to figure 5 below

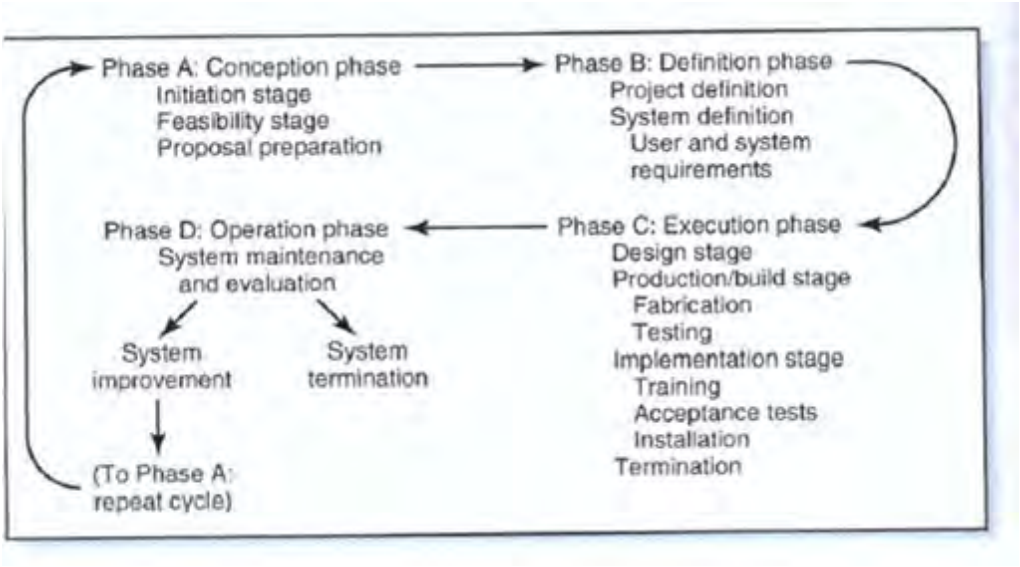


Figure 5: PLCM Stage-gate Model (Source: (Nicholas and Steyn, 2012: 537)

During this phase, friction arises as a result of cost and time overruns, technical problems, and labour issues affecting the project timelines (Nicholas and Steyn, 2012).

The project management tasks and deliverables include project tracking and review, documents, detailed project plan, quality assurance and control, risk

management, process management and change management (Cooper *et al.*, 2001; Nicholas and Steyn, 2012).

Project initiation/proposal	Procurement/contract management
Stakeholder identification	HR recruiting, training, layoffs
Project selection	Project tracking/review
Proposal development	Data entry
Project planning	Reporting to management
Requirements/specifications	Project auditing
Work definition	Quality control/assurance
Resource needds	Process control
Time and cost estimating	Change control
Scheduling	Project closeout
Budgeting/accounting	Post-project review
Risk analysis	Post-implementation review
	Knowledge management

Table 3: Project Management tasks and deliverables Source: (Nicholas and Steyn, 2012: 556)

2.4.11. Close-out Phase

In this phase, the product has to be handed over to the customer. The Project Manager should obtain the necessary approvals from all the stakeholders for project closeout. All the documentation is handed over to the relevant manager for configuration Management (Cooper, 1990; Phillips *et al.*, 1999; Kerzner, 2006; Nicholas and Steyn, 2012).

2.5.Checklist Defined

Checklist is defined as a "*planning and management tool used to determine potential drawbacks that permit corrective action before major problems can occur*" (Sanvido and Parfitt, 1993: 243). It can be used as a guideline to gather information for the identifying critical project success factors. The use of the checklist creates a basis of common understanding on key issues affecting project performance (Yao *et al.*, 2007).

Checklists are used as Go/Kill decision tools with a focus on individual projects and used for comparing projects against each other (Cooper *et al.*, 2001).
Checklist play a critical role for gate reviews and without these checklists Project Managers waste time preparing stage-gate review reports (Kerzner, 2006). A good checklist will focus on answering questions like:

- Where are we today (that is time and cost)?
- Where will we end up (that is time and cost)?
- What are the present and future risks?
- What assistance is needed from management?

2.6. Stage-gate system

2.6.1. Description of the stage-gate system

A stage-gate system is defined as "*both a conceptual and an operational model for moving a new product from idea to launch*" (Cooper, 1990: 44). It is a system that is essential for managing the new product process to improve effectiveness and efficiency. A stage-gate system is "a disciplined process that brings products through the corporate maze from concept to customer (Anderson, 1993). It has been suggested that "*the project must meet a set of criteria before it can pass through a gate and continue down the next project phase"* (Anderson, 1993: 34). Furthermore, use of a stage-gate system is recognized that product innovation is a process that can be managed. In addition to the above statement (Cooper, 1990) points out that there is a need for an effective new project management approach for sustained growth and competitive advantage due to increased competition, technical advancement and maturing markets; and in order to get better results, stage-gate systems are proposed.

The stages represent multiple activities, which take the product from idea creation to market launch. At each stage-gate, gatekeepers use a defined criteria to determine whether they should continue (go) or (kill) the projects (Leithold *et al.*, 2015).

Stage-gate development is a framework tool which allows the efficient and effective movement of a new product from idea to launch and it is applied to

product development processes of organisations. It aims at keeping the risk associated with new product development to a minimum (Phillips *et al.*, 1999; Claggett and Eklund, 2005). Risk is defined as the likelihood that some problematic event will occur *(Alali and Pinto, 2009; Nicholas and Steyn, 2012).* Risk in projects is referred to as risk of failure, implying that a project might fail on cost, time and technical performance criteria. Project risks are identified according to phases and stages in the PLCM and risk should be identified at each project phase. *"Risk identification starts in the conception phase and emphasis on the high risk factors that would have negative impact on the project"* (Nicholas and Steyn, 2012: 353).

The stage-gate system is a process management system for project management. Each process is subdivided into a number of stages. Each stage has its quality control check point which is called a 'gate'. A set of quality criteria and deliverables are specified for each gate, and the product concept must pass before moving to the next gate. The stages focus on the work that needs to be done and the gates focus on specified quality requirements of the product (Cooper, 1990).

Control gates which are also known as stage or decision gates are review points and provide early feedback on progress and enable more responsive decision making (Kerzner, 2006). Reviews are scheduled prior to the completion of a phase to assess progress, quality and problems. In addition to the above statement, stage-gates are used in between each phase to provide independent review and approval of key elements of the project. Stage-gate review meetings are planned at each phase and this includes the gathering, analysis, and sharing of information Kerzner (2006). This is done effectively with the use of checklists and these checklists are submitted together with the documentation that is required at each phase.

The Stage-gate review is the evaluation process by which a project is authorized to progress from one life cycle phase to the next and it serves as a quality control system. Furthermore, it is a collaborative practice in which the project participants play a vital role in assessing the project's overall health and quality

of execution to allow the Gate keepers to make an informed decision whether the project is ready to enter the next phase of its lifecycle and receive further resource commitments. It provides the Project Manager and the organisation the benefit of having an independent body to review the project.

Stage-gates are used in between each phase to provide independent review and approval of key elements of the project. Gate review meetings are planned at each phase and this includes the gathering, analysis, and sharing of information Kerzner (2006: 72). This is done effectively with the use of checklists and these checklists are submitted together with the documentation that is required.

Gates are established at regular phases of the project, both 'hard gates' and 'soft gates', to provide checkpoints through which projects cannot pass unless they match up to the expectations determined at the outset of projects (Keegan and Turner, 2002).

2.6.2. The role of quality costing

The cost of quality is an indication of where corrective action will be profitable for an organisation. Furthermore, the only measure of quality is the price of non-conformance. Quality costs can be eliminated if the project costs can identified (Crosby, 1979; Goulden and Rawlins, 1994). In order to prevent unnecessary project costs, a project cannot proceed without a 'go' decision by the appropriate senior management for a specific stage-gate.

Cost of quality is usually understood as *"the sum of conformance plus non-conformance costs, where cost of conformance is the price paid for prevention of poor quality (for example, inspection and quality appraisal) and cost of non-conformance is the cost of poor quality caused by product and service failure"* (Schniffaurova and Thomson, 2006: 647).

2.6.3. Quality Cost Models

The costs associated with quality include the following (Gryna, 2001):

- **Internal failure costs:** These are the costs of deficiencies discovered before delivery that are associated with the failure to meet explicit

requirements or the implicit needs of customers. Internal failures costs consist of cost of failure to meet customer requirements and cost of inefficient processes. For instance project spares arriving on site and not meeting customer requirements

- **External failure costs:** These are costs associated with deficiencies that are found after production is received by the customer. It consists of lost opportunities for sales revenue
- **Appraisal costs:** These are costs incurred to determine the degree of non-conformance to quality requirements
- **Preventive costs:** These are costs incurred to keep failure and appraisal costs to a minimum. Examples are quality planning, new products review, process planning, process control, quality audits and training (Goulden and Rawlins, 1994; Gryna, 2001; Schniffaurova and Thomson, 2006).

2.6.4. Characteristics and use of the Stage-gate system

Stage-gate system consists of stages and gates. Stages are groups of activities that can be performed either in series or parallel based on the level of risks the project can tolerate. Furthermore, the stage-gates are managed by cross functional teams. *Gates are structured decision points at the end of each stage* (Kerzner, 2006: 64). The stage-gate system is "*characterised by checkpoints (gates), with both upstream and downstream sequential progress of phases" (Leithold et al., 2015: 132)*. Stage-gates are established at regular phases of the project, both 'hard gates' and 'soft gates', to provide checkpoints through which projects cannot pass unless they match up to the expectations determined at the outset of projects (Keegan and Turner, 2002). It is at these checkpoints that the success criteria identified is assessed.

The application of the stage-gate system is a team effort between project planners and project engineers and its application can result in time savings (Ettlie and Elsebach, 2007; Zwane *et al.*, 2014). The application of the stage-gate model reduces the cost of the project to a minimum level and can enhance the competitiveness of the projects (Tomas *et al.*, 2011). The stage-gate system is used as a "*basis for sustainable project management due to its comprehensive approach and the way it can be adapted to various industries*"

(Claasen *et al.*, 2005: 40). Figure 6 illustrate what a stage-gate which consists of, it also shows the set of information followed by a Go/Kill Decision gates.

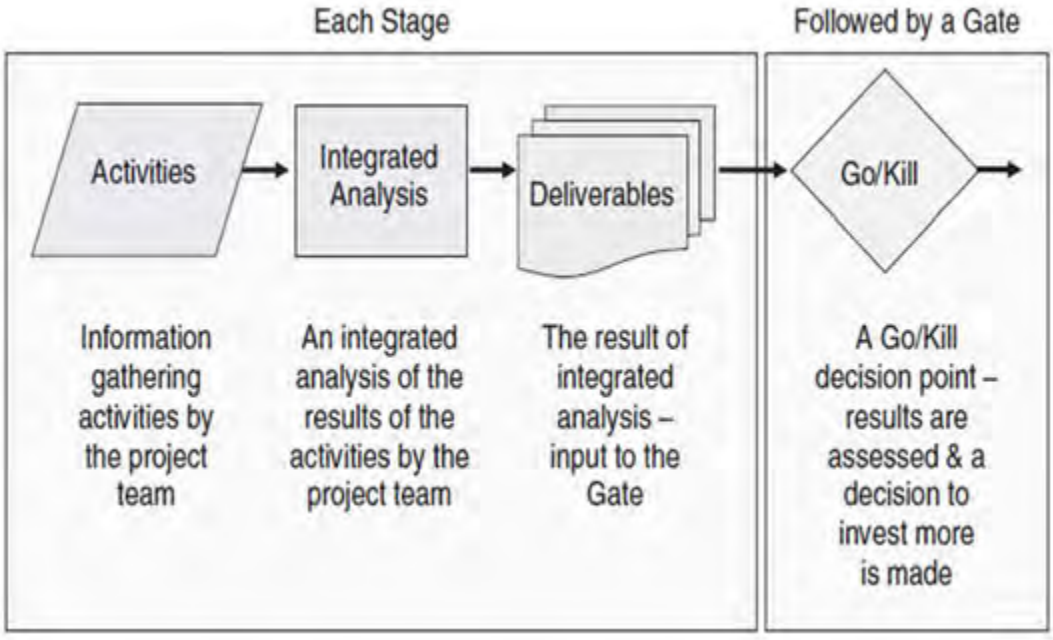


Figure 6: Stage -gate (Source: (Cooper, 2008a: 214)

Each stage consists of the required activities needed to progress the project to the next decision point (Cooper, 2008a: 214; Chao *et al.*, 2014). Stages are designed to collect information in order to reduce project risks and the purpose of each is clearly defined. Furthermore, the activities within stages are done parallel by the project team.

Gates serve as quality control check points and consist of the following aspects:

- **Deliverables:** These deliverables should be visible and be based on project requirements and specifications
- **Criteria:** Include a checklist and specific criteria that must be meet in the project
- **Outputs:** Include agreed timelines, resources and a decision (Go/Kill) together with an authorised action plan for the next stage (Cooper, 2008a).

(Cooper, 2008a) points out that a stage-gate should not be:

- **A functional, phased-review process:** Stage-gates are cross functional and not controlled by a single functional area. The project is executed by a dedicated and competent team. The Activities occurs in parallel and governance process is clear, with defined criteria for making decisions on time
- **A rigid, lock-step process:** A stage-gate is a map to get from an idea stage to product launch. Project activities can be wavered depending on project requirements and not all project pass through every stage or gate model
- **A linear system:** Some activities are carried out in sequence, others in parallel and others overlap
- **A project control mechanism:** The stage-gate is designed to assist Project Managers and project teams to get resources for their projects. It is not risk intended to be control system
- **A data entry scheme:** The stage-gate consists of a set of information-gathering activities
- **A bureaucratic system:** The stage-gate is a systematic, streamlined process
- **The same as project management:** The stage-gate is not a substitute for sound project management methodologies. Project management methods are applied within the stages of the stage-gate process
- **A dated, stagnant system:** The stage-gate is not a static tool but is rather a comprehensive, integrated system that builds in best practices methods.

Stage-gates are run as two part meetings as shown figure 7 below. The first part is known as the ‘left diamond’, projects are assessed in accordance with specific project requirements, set standards and a pass or kill decision is made. The second part is referred as the ‘right diamond’, projects are evaluated against other projects and their impacts on the portfolio management. A Go or Hold decision is made at this second part. During this two part gate structure, resources are allocated into the project once the benefits of continuing with the project have been established (Cooper *et al.*, 2002).

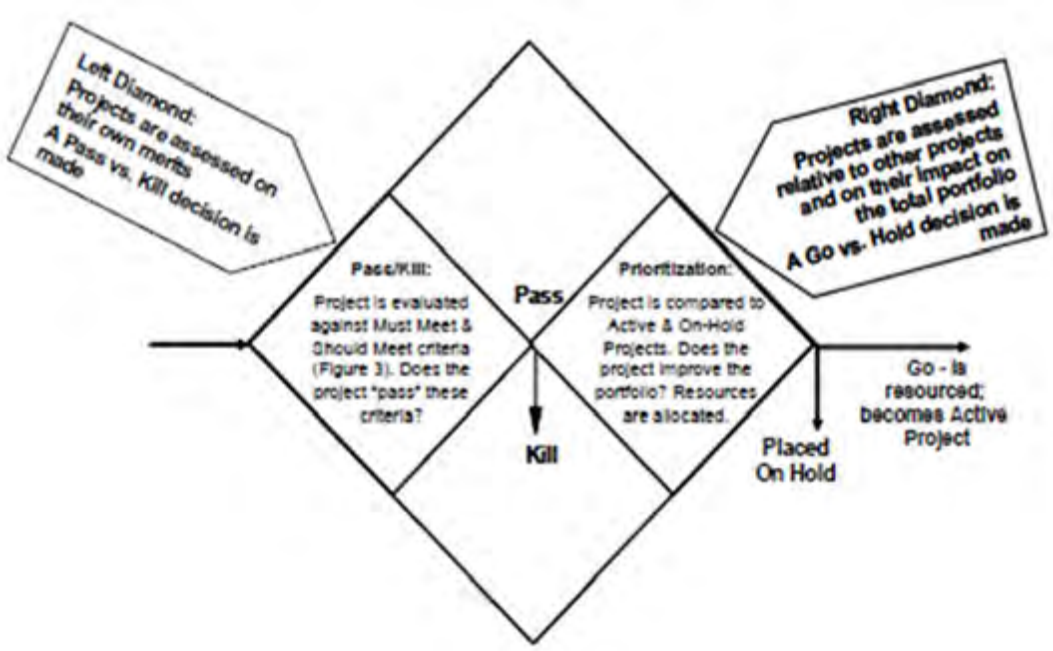


Figure 7: Two part decision process - Gate meetings Source: (Cooper *et al.*, 2002)

The stage-gate system focuses on the key business decisions in new product development (NPD). It aims at reducing project development time and cost, and help co-ordinate the application of other new tools within the technical domain and business decisions (Shaw *et al.*, 2001). The stage-gate framework used in NPD consists of five phases and five gates as shown in figure 8 below. The role of each phase is to *"detail, structure and generate the information required at each gate, from which a decision will be made"* (Shaw *et al.*, 2001: 1143). Each stage-gate helps to focus the decision of whether to continue developing the proposition. Prior making a decision, the information processed by the specified analysis and the "*higher the phase and gate number, the greater detail is required"* (Shaw *et al.*, 2001: 1143).

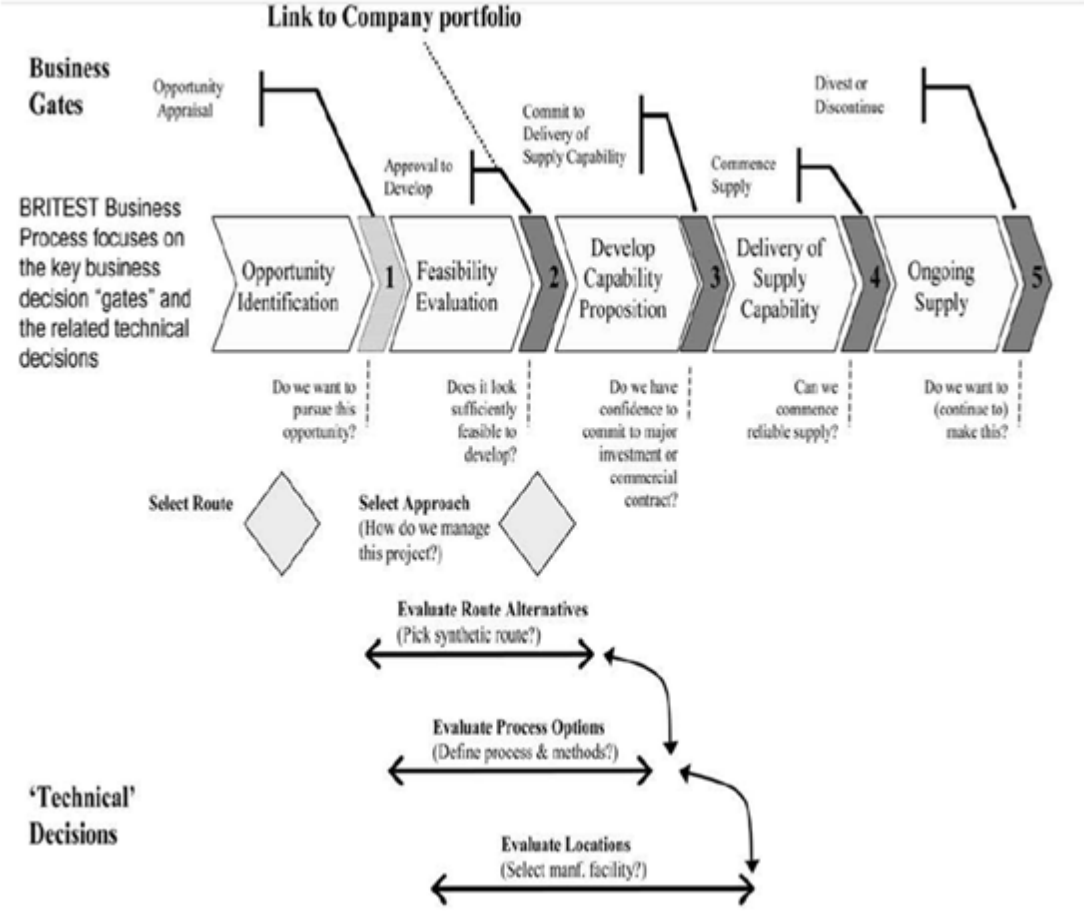


Figure 8: Business gate framework for the NPD Source: (Shaw *et al.*, 2001: 1143)

Each phase and stage is explained below:

- **Phase and gate 1 - Opportunity Identification:** The market opportunity is reviewed and assessed whether it is worthwhile investigating the organisation's capability to embark on the new product or project. Project specifications, cost estimates are considered at this stage
- **Phase and gate 2 - Feasibility Evaluation:** This phase and gate aims at determining whether the organisation is prepared to commit funds to embark on the new product or project. Project requirements, specifications, criteria, risk assessment, and environmental and safety issues to be addressed at this stage
- **Phase and gate 3 - Develop the capability proposition:** The capability required for the project is identified. The objective of this phase and gate is to ensure that the organisation gains the capability necessary to define how the supply capability can be delivered

- **Phase and gate 4 - Delivery of supply capability:** This stage aims at establishing the asset base and generates all the information necessary to manage projects from start-up to full scale supply capability
- **Phase and gate 5 – On-going supply:** The most effective approach is to conduct periodic reviews across all projects. Considerations for this final phase may include:
    - Does the product still fit into markets actively being pursued by the company?
    - Is the product still profitable, i.e. of strategic or monetary value to the organisation?
    - Is the product market still buoyant financially or is it under threat?
    - Are there any impending constraints to this market to consider, such as future legislation? (Shaw *et al.*, 2001).

2.7. The purpose of a stage-gate system

The purpose of the gates is not only to gain authorisation to proceed with the project but to also identify non-conformances early enough in order to ensure that resources are assigned to the project and more support is provided where necessary (Kerzner, 2006). Non-conformance is a non-fulfilment of a requirement or the failure of a product to meet a specified requirement (ISO, 2008).

"Gates ensure that no critical activities are omitted at each gate and an action plans are agreed at each gate and the deliverables for the next gate are clearly defined" (Cooper, 1990: 48). Furthermore, the result is no critical errors of omission, no gaps in the process, and a process is deemed as "complete". Furthermore, stage-gate systems normally highlight a market orientation and marketing inputs, and they assign more attention to the project stages that follow the product development phase.

2.8.ADVANTAGES OF A STAGE-GATE SYSTEM

Cooper points out the following advantages of a stage-gate system, it:

- Provides the quality focus that is often missing in firms' projects (Cooper, 1990)
- Include its structured subdivision and joint decision-making (Leithold *et al.*, 2015)
- Ensures that the project meets the defined quality requirement at each quality check point at each stage (Cooper, 1990)
- Builds in quality control checkpoints in the form of gates (Cooper, 1990)
- Ensures projects that are not relevant to the business strategy can be terminated at any stage (Nicholas and Steyn, 2012)
- Ensures that project leaders and teams meet specified requirements and standards of executing a project. For instance as the project leader approaches a gate, he or she knows what inputs are required and that these deliverables will be carefully scrutinized by the senior managers who act as gatekeepers (Cooper, 1990)
- Includes increased better quality, greater discipline, and better overall performance compared to informal development processes (Sommer *et al.*, 2015)
- Provides for a much stronger market orientation in the new product process (Cooper, 1990)
- Reduces cost of project to a minimum level and can enhance the competitiveness of the projects (Tomas *et al.*, 2011)
- Resources are planned and allocated for stronger and promising projects which improve the prospect of meeting the organisation’s requirements (Nicholas and Steyn, 2012)
- Can be custom made for each project to facilitate decision-making and risk management (Kerzner, 2006)
- Provide a road map for the project leader and team. The project team members, often come from different departments within the organisation, they have different disciplines. By using a stage-gate system when executing a project it provides the whole project team a clearer idea of

how the project is progressing, where it is going, and what needs to be done before moving to the next project phase (Cooper, 1990)

- Provides an overview of the entire new product process for senior managers giving direction and also for better management and control (Cooper, 1990)
- Provides a set of objectives for the project leader. The pre-specified inputs to each gate become the objectives for the next time period. For instance, the required inputs to Gate 2 in figure 2above might include:
  - **Market analysis**: Size, growth, segmentation, trends
  - **Competitive analysis:** Players, market, shares, strategies
  - **Customer reaction:** Reaction to concept, price sensitivities
  - **Development appraisal:** Feasibility, route, times and costs
  - **Production appraisal:** Feasibility, route, times and costs
  - **Legal:** Initial assessment from legal
  - **Financial:** Payback period (Cooper, 1990).

2.9.PROBLEMS FACED BY ORGANISATIONS USING A STAGE-GATE SYSTEM

Stage-gates are rated as one of the weakest areas in product development, with only 33% of firms having tough rigorous gates throughout the idea-to-launch process (Cooper, 2008a).

(Kerzner, 2006), points out the following problems associate with using the stage -gate system:

- Assigning gatekeepers and not empowering them to make decisions
- Assigning gatekeepers who are scared to terminate a project
- Denying the project team access to critical information
- Allowing the project team to focus more on gates than on the stages.

(Cooper, 2008a) describes the following aspects:

- Most common complaint is that even though the organisations have implemented a stage gate system, the gates, which are the important component decision-making process, are either non-existent or lack

authority. The gates have no authority, once a project is approved, it never gets killed.

- At the gate review meeting, projects are approved, a go decision is made, but resources are not committed. This is referred to a hollow go decision. Furthermore, stage-gates are where "gatekeepers" meet to make a decision whether the organisation should continue investing in a project based on the latest information available. Stage-gates are a resource commitment meeting, where, in the event of a go decision, the Project Manager and team should receive a commitment of resources to progress their project.

(Cooper, 2008a) points out the following dysfunctional of the Gatekeepers in stage-gate review meetings:

- Executive projects receiving special treatment and bypassing the gates
- Gate meetings cancelled at the last minute because the gatekeepers are unavailable (yet they complain the loudest when projects miss milestones on the timeline)
- Gate meetings held, but decisions not made and resources not committed
- Key gatekeepers and resource owners missing the meeting and not delegating their authority to a designate the meeting thus becomes impotent
- Go/kill decisions based on opinion and speculation rather than on fact
- Using personal and hidden go/kill and prioritization criteria rather than transparent decision-making criteria.

Some problems associated with the use of the stage-gate process and these are:

- Too many "must do" projects, organisations seem to respond to customer and market pressures and don't want to lose their customers
- No mechanism to kill or control projects once they are approved and there are serious Go/Kill decision points built into the stage gate process
- Criteria for making Go/Kill decision and prioritising projects have often not been properly established

- Senior Management which are referred as gate keepers are busy thus scheduling the Go/Kill decision meetings becomes a challenge (Cooper *et al.*, 2002).

One view point expressed is that "*stage-gate model can be time consuming because of the need to complete one stage before moving on to the next*" (Ottosson, 1996: 155).

2.10. BENEFITS OF THE STAGE-GATE SYSTEM

Stage-gate system "*reduce risk associated with the product's development and it permits the organisation to improve the quality of the output, by focusing on the process itself, in being able to remove non-value-added activities in the process*" (Phillips *et al.*, 1999: 290). Some of the benefits identified include the following:

- Provides structure to project management (Kerzner, 2006: 65)
- Builds in quality control checkpoints in the form of gates (Cooper, 1990)
- Ensures projects that are not relevant to the business strategy can be terminated at any stage (Nicholas and Steyn, 2012: 583)
- Provides possible standardisation in planning, scheduling and control (Kerzner, 2006: 65)
- Ensures that project leaders and teams meet specified requirements and standards of executing a project (Cooper, 1990)
- Includes increased better quality, greater discipline, and better overall performance compared to informal development processes (Sommer *et al.*, 2015)
- Yields positive results in terms of getting new products and services to market fast, efficiently and profitably (Cooper, 2008b: 22).

The use of the stage-gate system prevents cost overruns, poor quality and can reduces stress levels of the Project Manager because the projects have to be closed both administratively and contractually during the close out stage. The use of the stage-gate system provides an overview of the project progress for senior managers giving direction and also for better management and control.

2.11. CONCLUSION

The stage-gate review process is a tool which allows the efficient and effective movement of a new project from idea to launch. It aims at keeping the risk associated with new product development to minimal (Phillips *et al.*, 1999; Claggett and Eklund, 2005). Each process is subdivided into a number of stages or work stations. Each stage has its quality control check point which is called a 'gate'. A set of quality criteria and deliverables are specified for each gate, and the product must comply before moving to the next gate. The stages focus on the work that needs to be done and the gates focus on specified quality requirements (Cooper, 1990). At each stage-gate, gate keepers use defined criteria to determine whether they should continue (go) or (kill) the projects (Leithold *et al.*, 2015).

The stage-gate system reduces the cost of project to a minimum level and can therefore enhance the competitiveness of the projects. For instance cost overruns are minimised on the projects that are using the stage-gate process because projects are evaluated and monitored in each project phase prior proceeding to the next project phase. This is done to ensure that all project costs are kept to a minimum and project requirements are met. Project Managers and the business can both benefit from the effective use of the stage-gate system. All information pertaining to projects can be easily traced.

3. RESEARCH METHODOLOGY

3.1. Introduction

This chapter describes the research methodology used to address the research question highlighted in Chapter 1:

What value does the stage-gate review process add to projects in the power plant?

The PLCM model, stage-gate system, purpose, advantages, benefits and problems of the stage gate system have been described in the previous chapters. The first step in the research methodology is to establish what methodologies and tools to use to analyse PLCM stage-gate reviews and assess the effectiveness of conducting stage-gate reviews within the PLCM. The second step in the research methodology is to determine the impact of not conducting PLCM stage- gate reviews.

A sample was taken from the Project Manager complement of the power plant to establish the impact of not conducting PLCM stage-gate reviews in the project management arena. Various research methods are described in this chapter. The case study approach is described in detail as the research strategy which is best aligned to answer the research questions. The Koeberg Operating Unit which, referred to as the nuclear power plant in this report, has been selected as a convenient organisation to perform the case study (Eskom, 2013).

3.2. Case Study / Case Research Approach

A case study is defined as "*an in-depth investigation of a problem in one or more real life settings over an extended period of time*" (Bhattacherjee, 2012: 31). It is a research strategy that can use both qualitative and quantitative research methods and can also be used for theory testing and theory building. The case study uses multiple data sources and data can be collected by means of conducting interviews, personal observations and internal or external documents (Yin, 1981; Eisenhardt, 1989; Chetty, 1996 ; Rowley, 2002; Punch, 2005; Hancock and Algozzine, 2006; Bhattacherjee, 2012). It aims to test research

questions and issues, by setting these in a contextual and often causal context (Cassell and Symon, 2004).

The case study is useful in providing answers to "how", what and "why" type of questions and *in this role can be used for exploratory, descriptive or explanatory research* (Rowley, 2002: 16). Case studies are useful for explaining the contextual conditions relevant to the research study (Yin, 2009).

Case studies are used to accomplish several aims such as to provide description, test theory or to build a new theory (Eisenhardt, 1989). The case study approach develops a road map for building theories, and can involve either a single or multiple cases and various levels of analysis (Eisenhardt, 1989). The types of research question are significant in determining the most appropriate research approach to be selected and it also depends on the scope of the research (Rowley, 2002). Case studies can involve single or multiple cases (Rowley, 2002). In this research project a single case has been selected. A single case study of a nuclear power plant, with which a number of projects are examined. It allows researchers to perform an in-depth investigation on the case for better understanding. It is performed to confirm a theory a single experiment. It provides valuable information about the research question (Cassell and Symon, 2004). It uses the critical case sampling strategy to test, challenge or extend existing theory (Neergaard and Ulhøi, 2007)

Case studies are classified into holistic or embedded studies. *Holistic studies investigate the case as one unit which normally focuses on the issues of organisational culture or strategy* (Rowley, 2002: 22).

3.2.1. Advantages of case studies

Several authors have pointed out the following advantages of case studies:

- Useful tool for the preliminary, exploratory stage of a research project and it can be used as a basis for the development of the 'more structured' tools that are necessary in surveys and experiments (Rowley, 2002)
- Both single and multiple sources of evidence can be used to develop theory (Eisenhardt, 1989)

- Useful in theory building and can be used to test hypotheses (Stake, 1978)
- A valuable tool that measures and records behaviours and data can be collected from different sources (Chetty, 1996)
- Useful for exploring new or emerging processes or behaviours (Cassell and Symon, 2004)
- The performance and decision making process of the company is improved by understanding the research problem (Chetty, 1996)
- Ideal for studying research topics where existing theory is inadequate Chetty (1996 82)
- Have an important function in generating hypotheses and building theory (Cassell and Symon, 2004)
- Useful in capturing the emergent and changing properties of life in organizations (Cassell and Symon, 2004)
- Can be used to understand everyday practices and their meanings to those involved in research studies (Cassell and Symon, 2004)
- May be essential in cross-national comparative research (Cassell and Symon, 2004).

3.2.2. Disadvantages of case studies

Case studies have the following disadvantages:

- Time consuming and require more effort to construct readable stories for data elements (Yin, 1981)
- Are descriptively inexhaustible, and any description involves cultural interpretations that are always potentially open to question (Hammersley *et al.*, 2009)
- Provides little basis for generalisation (Chetty, 1996)
- Are not suitable for scientific and statistical generalisation (Chetty, 1996).

3.3. Research Philosophy

The purpose of research is to make clear assumptions when conducting qualitative research and to understand the dynamics of the worldviews, paradigms related to certain problem. There are several ways to understand the worldview (Creswell, 2007; Maree, 2007). (Gioia and Pitre, 1990: 555) define a paradigm as a "*way of thinking that reflects fundamental beliefs and assumptions about the nature of organizations*".

- **The functionalist paradigm:** It is regarded as an objectivist view of the organizational worldview with an orientation toward stability of the status quo
- **The interpretive paradigm:** It is regarded as a subjectivist view, also with an apparent concern with regulation. As per (Gioia and Pitre, 1990) we are trying to describe and explain what value does stage gate review add into projects. The aim of this paradigm is to describe and explain in order to understand the research problem. In this research project, interviews with Project Managers, programme managers will be conducted. Data will be collected, analysed and interpreted
- **The radical humanist paradigm:** It is regarded as a subjectivist view, but with an ideological orientation toward radically changing constructed realities
- **The radical structuralist paradigm:** It is characterised by an objectivist stance, with an ideological concern for the radical change of structural realities (Gioia and Pitre, 1990).

Data collection process is grouped into two categories:

- **Positivist methods:** Aims at testing theory and uses experimental data, mainly uses quantitative data but it can also use qualitative data
- **Interpretive methods:** Aims at building theory for instance action research and ethnography. It relies on qualitative data (Bhattacherjee, 2012).

In this research project an interpretive method has been used to collect data because it aims at building theory and it relies on qualitative data (Bhattacherjee, 2012). Table 4 below provides the paradigm differences affecting theory building

Interpretivist Paradigm	Radical Humanist Paradigm	Radical Structuralist Paradigm	Functionalist Paradigm
Goals To DESCRIBE and EXPLAIN in order to DIAGNOSE and UNDERSTAND	**Goals** To DESCRIBE and CRITIQUE in order to CHANGE (achieve freedom through revision of consciousness)	**Goals** To IDENTIFY sources of domination and PERSUADE in order to GUIDE revolutionary practices (achieve freedom through revision of structures)	**Goals** To SEARCH for regularities and TEST in order to PREDICT and CONTROL
Theoretical Concerns SOCIAL CONSTRUCTION OF REALITY REIFICATION PROCESS INTERPRETATION	**Theoretical Concerns** SOCIAL CONSTRUCTION OF REALITY DISTORTION INTERESTS SERVED	**Theoretical Concerns** DOMINATION ALIENATION MACRO FORCES EMANCIPATION	**Theoretical Concerns** RELATIONSHIPS CAUSATION GENERALIZATION
Theory-Building Approaches DISCOVERY through CODE ANALYSIS	**Theory-Building Approaches** DISCLOSURE through CRITICAL ANALYSIS	**Theory-Building Approaches** LIBERATION through STRUCTURAL ANALYSIS	**Theory-Building Approaches** REFINEMENT through CAUSAL ANALYSIS

Table 4: Paradigm Differences Affecting Theory Building: Source: (Gioia and Pitre, 1990: 591)

There are five philosophical assumptions that lead to an individual's choice of qualitative research namely: ontological assumptions, epistemological assumptions, axiology, human nature and methodological assumptions. Each philosophical assumption is discussed in detail in the context of this research.

- **Ontological assumptions:** Relates to the nature of organisation and its characteristics. The project management organisation consists of Project Managers, project leaders, programme managers and project supervisors. In this research ontological assumptions refers to the value of stage gates which is being questioned (constructed reality)
- **Epistemological assumptions:** Understanding nature, origin and scope and nature of knowledge. The project management organisation consists of Project Managers, project leaders, programme managers and project supervisors and they are a dynamic team since they have different

professional background for instance Mechanical Engineers, Electrical Engineers, Civil Engineers, Project Management Practitioners, Health and Safety Practitioners, Quality Management Practitioners, System Engineers, Procurement Practitioners. This is considered to be subjective.

- **Axiology:** Aesthetics, ethics and justice. This is considered as an objectivist paradigm. Ethics is referred to as *"the appropriateness of your behaviour in relation to the rights of those who become the subject of your work, or are affected by it"* (Watkins, 2008: 69). This research involves human participants to collect the data and confidentiality is vital. In this research, ethics will be declared and ethics forms will be completed.
- **Human nature** (Rhetorical): Understanding the relationship between the human individual and the society. In this research, understanding and benefits of conducting stage-gate reviews will be established
- **Methodological assumptions:** Refers to the nature of ways of studying phenomena (Kagioglou, 2000; Denzin and Lincoln, 2005; Creswell, 2007). In this research methodological assumption refers to the methods used to manage projects. PLCM is the method used to manage projects and stage-gate is the tool used to monitor project progress.

For any research, developing theory is vital to resolve the research problem. This theory should be aligned with the research problem to be investigated (Eisenhardt, 1989).

3.4. Research Strategy

Research strategy is a high level approach which determines the detailed work that needs to be done (Yin, 2009). The research strategy is based on the research strategy described above. The data has been collected from a specified sample to answer the research questions. Data collection may include qualitative or quantitative research approaches and the evidence may come from fieldwork, archival records, verbal reports, observations (Yin, 1981; Yin, 2009). A case study also known as case research which combines qualitative and quantitative methods is used and it is described in detail in the following sections.

The sources of case study data collection include (Tellies, 1997a)

- **Documents:** Letters, agendas, administrative documents, newspaper articles or other documents related to the investigation
- **Archives:** Service records, organisational records, lists of names, survey data, and other records related to the investigation
- **Interviews:** Open ended, focused, formal, and structured survey interviews
- **Direct observations:** Practical observations to collect data through site visits, or formal protocols to record or measure behaviours.

In this research project, the data has been collected by gathering information about perceptions pertaining to the stage-gate review process from respective Participants in the form of conducting interviews. Various documents including project report, Pproject Manager's file, has been reviewed.

3.5. Research methodology

Research methodology refers to the procedural framework within which the research is conducted and research method refers to various ways in which data can be collected and analysed (Bhattacherjee, 2012). Quantitative research methods may be used to obtain a response from a large number of respondents through the questionnaires. The collected data is then analysed using statistical methods (Wisker, 2008). Qualitative and quantitative methods refer to the type of data being collected. Qualitative data includes conducting individual interviews, focus groups, reviewing existing documents, and observations (Rowley, 2002; Hancock and Algozzine, 2006; Wisker, 2008; Bhattacherjee, 2012). In this research project data has been collected by means of conducting individual interviews and reviewing existing documents.

3.6. Research Design

3.6.1. Conducting Case Study

It is suggested that "*most case studies tend to be interpretive in nature"* (Bhattacherjee, 2012: 95). Furthermore, interpretive case study is defines as "*the technique where evidence collected from one or more case sites is systematically analysed to allow concepts to emerge for the purpose of building*

new theory". (Eisenhardt, 1989), suggest a "road map" for building theory to describe a phenomenon for further investigation. The case study approach consists of the following stages: define research questions, select case site, create instruments and protocols, select respondents, start data collection, conduct within-case data analysis, conduct cross-case analysis and build and test hypothesis and writing case research report (Bhattacherjee, 2012).

After the case study is designed, the next step is to implement the design strategy to gather information related to the research. Researchers should acquire sufficient knowledge about the case study prior to the data collection (Rowley, 2002). Data collection is guided by the content of the case study project which may include: an overview of the case study project; different sources of information and case study questions needs to keep in mind when collecting data (Rowley, 2002). In accordance with (Rowley, 2002), the Researcher should also gather proper evidence to support the collected data.

3.6.2. Research Design Considerations

Research design is defined as a "*comprehensive plan for data collection in an empirical research project*" (Bhattacherjee, 2012: 35). It links the data to be collected and the conclusions to be drawn to the initial questions of a study and it ensures consistency (Cassell and Symon, 2004). Furthermore, it can be used as an action plan for getting from the questions to conclusions. It involves defining the basic components of the investigation, *such as research questions and research propositions, appreciating how validity and reliability can be established, and selecting a case study design* (Rowley, 2002: 18). In addition to the above statements, the research design objective is to answer the specific research questions and must specific at least three processes namely: the data collection process; the instrument development process and the sampling process.

It can be used with other research strategies to address related research questions in different phases of a research project (Cassell and Symon, 2004). It is crucial to develop a research design for research methodology as it can be used as an action plan to get appropriate answers to the research questions

(Maree, 2007). A research design consists of the following five key components: a study question, a proposition, a unit of analysis, the logic linking the proposition to the data and the criteria for interpretation of the findings (Rowley, 2002; Yin, 2009; Bhattacherjee, 2012).

3.6.3. Case study design

The research is conducted as a case study on Koeberg Operating Unit; refer to Appendix A for detailed information on the research environment. The NPM department is the case unit for this research project refer to Appendix A for detailed information on research environment. The unit of analysis is the modifications performed at the power plant which falls under the governance of the stage-gate system.

3.6.4. Case Study Sources of Data

The sources of data that are considered in this research project are the following:

- **Interviews will be conducted:** A questionnaire has been prepared using a structured approach to conduct interviews
- **Documentation to be used:** Policies, procedures, work instructions and guidelines on project management processes and PLCM.

3.7. Ethics Issues

Ethics is referred to as *"the appropriateness of your behaviour in relation to the rights of those who become the subject of your work, or are affected by it"* (Watkins, 2008: 69). Research ethics set out the following principles: it ensures the voluntary consent of the Participants; only properly qualified people may conduct the research study; experiments must be for the good of society and unnecessary harm must be avoided.

This research involves human Participants to collect the data and confidentiality is vital. Research Participants are fully informed about the nature of the research study, give their consent to be involved, the privacy of Participants must be maintained, sources of funding where appropriate should be declared and data should be kept confidential and anonymous where appropriate (Bell and Wray-

Bliss, 2009). The following ethical issues will be addressed during this research study:

- **Informed consent:** Participants should be given the choice to participant or not to participate, and furthermore be informed in advance about the nature of the study. The Participants were informed that there will be enough time to reflect on their contribution and change information if necessary
- **Right to privacy:** The nature and quality of Participants' performances will be kept strictly confidential
- **Honesty with professional colleagues:** Findings will be reported in a complete and honest fashion, without misrepresentation
- **Confidentiality/anonymity:** Confidentiality and anonymity will apply to questionnaires, as this will lead to participants giving more open and honest responses.

The role of the Researcher is embedded within the organisation. The research Participants was mainly the peers of the Researcher and there was no power difference between the Participants and the Researcher. There were no issues related to power difference when interviewing Senior Managers as integrity and professionalism was maintained. The security of individual researchers should be considered where the interview is to be carried out at the interviewee's home or in a context or location where common sense would suggest caution (Cassell and Symon, 2004). In this case, the interviews were conducted in a well-protected and secured environment, the premises of the power plant. The security of information is normally transmitted by electronic networks. Computer viruses are an increasing problem and some people are unwilling to open e-mails from people that they don't normally deal with on a day to day basis (Cassell and Symon, 2004). Therefore, the NPM secretary was requested to send an introductory e-mail to the Project Managers who were participating in this research study. Furthermore, the nuclear power plant's computer system that controls access to and from other computers particularly email and internet has been set to high standard in order to protect the power plant employees and the company information from viruses. In this research study the security of the Researcher and Participants was not an issue because the research interviews were conducted in the nuclear power plant premise which is regarded as a

national key point meaning the security of information and personnel is of high importance.

Data has been interpreted in a professional manner dealing with the Researcher's feeling about information provided by research Participants was not an issue as the Researcher is distant from the topic being researched (from another department). *"Subjectivity and personal interpretation of matters of crucial importance to individuals increases the likelihood of ethical considerations"* (Cassell and Symon, 2004: 56). Therefore, confidentiality issues must be respected as respondents may name other people and/or may insult their businesses. In such cases *"a strict code of ethics and a procedure for handling tape-recorded and transcripted material is essential in order to protect all parties and the integrity of the research process"* (Cassell and Symon, 2004).

4. DATA COLLECTION AND ANALYSIS

4.1. Introduction

In this research study, a single holistic case study was performed on the nuclear power plant based on the research design to answer the research questions. The projects examined could be fitted with two categories (group A and group B projects) based on the time the stage-gate review process was introduced. The group A projects category were implemented prior the use of the stage-gate review process and some were considered strategic projects. All Projects that fall in group B project category were performed under the governance of the stage-gate review process and these projects followed the Project Life Cycle Model. In the group B project category, the strategic projects were carried out using the stage-gate review process. However, less critical projects were introduced in the stage-gate process.

This chapter is divided into three parts. The first part will provide a brief overview of data collection and data analysis. The second part will cover document reviews and the researcher conducted interviews with the NPM Project Mangers from various group sections using a questionnaire described in section 3.5. The third part covers interview results which are described and analysed to identify the impact of not conducting stage-gates reviews effectively.

4.2. An Overview of data collection and analysis

Data analysis is defined as '*the process of bringing order, structure and meaning to the mass of collected data' (De Vos, 2002: 339)*. Furthermore, it is an iterative and on-going process requiring validation and legitimation (Miles and Huberman, 1994).

This chapter describes methods of data analysis, which were used by the Researcher for the purpose of determining the value of project stage-gates

within a nuclear power plant. The purpose was also to explore how NPM perceived the value of stage-gates in the execution of projects.

An essential part of research is data analysis, hence such analysis and the decision regarding appropriateness of analytical methods must be made in relation to the nature of the research problem (Walliman, 2005) which, as stated in Chapter 1 paragraph 1.7, reads: *'The stage-gate review process is not used by some projects that are mandated to do so'*. The methodology that was described in the preceding chapter provided the baseline for data gathering. In this chapter data which was obtained from the completed questionnaires are presented and analysed.

Data was analysed as follows: description of the sample, data format, and methods of data analysis, main results, discussion, presentation and interpretation of the results. This was then followed by a discussion of the research findings. The findings related to the research questions that guided the study. Data was analysed to determine the value of project stage-gates within a nuclear power plant.

4.3. Document Review

This section has been covered in more detail in Appendix B

The document review covers some projects that were implemented prior the use of the stage-gate review process. It also includes projects that started after the stage-gate review process was implemented. The use of the stage-gate review process referred to as "group A project" and projects performed that falls under the governance of the stage-gate review process and are referred to as "group B project". The unit of analysis for this research study were both "group A project" and "group B project".

4.3.1. Group "A" project category

The project of this category were implemented prior the use of the stage-gate review process. The procedure for managing projects in the nuclear power plant was followed from the start of the project until the project close out. Ten projects

that followed this approach were reviewed and the following problems were found:

- Quality Assurance Data Package (QADP) were incomplete
- Project information on the Project Managers file were incomplete
- Project Managers were unable to hand over the projects to the Client due to missing information pertaining to projects
- Configuration management was a problem due to missing project files
- Project Managers had challenges with closing out projects
- During project close out projects are closed administratively and contractually as planned and this created a number of problems because Project Managers couldn't find the missing information
- Delegation Consent Forms (DCF) were not signed by Project Managers and some of the DCF's could not be found
- Cost overruns
- Scope creep
- Poor quality work
- Traceability of project information was a problem because there was no structured approach for managing project documentation
- Project monitoring and reviews was not done appropriately.

Ten projects from group A project category were reviewed. Out of the ten projects that were reviewed, the project management organisation was able to hand over three projects to the client organisation successfully. This was due to the problems that were experienced during the commissioning of these projects. There were problems associated with: cost overruns, scope creep, poor quality work, incomplete Quality Assurance Data Package (QADP) and incomplete project information on the Project Managers file.

4.3.1. Group "B" project category

All Projects that falls in this category were performed under the governance of the stage-gate review process. These projects followed the Project Life Cycle Model (PLCM) and the following phases were used during the project life cycle: Conception Release Approval (CRA), Definition Release Approval (DRA), Execution Release Approval (ERA) and Finalisation Release Approval (FRA).

The projects that followed the stage-gate review process were mainly the strategic projects. Five projects under the governance of the stage-gate review process were reviewed and the following key points were observed:

- A need or opportunity was reviewed
- The Statement of Work (SOW) or User Requirement Specification (URS) was compiled during the Pre-Planning phase
- Project documentation is monitored at each phase (prior proceeding to the next phase)
- Prevention of cost overruns
- Poor quality is prevented and if it occurs it is addressed immediately
- No scope creep
- Project information is easily retrievable and accessible
- Project close out is manageable
- Projects are handed over to the Client on time as required
- Business Realisation is performed adequately
- Project traceability is no longer an issue.

The five projects are scheduled for commissioning when there is a maintenance shutdown beginning of 2019 and the other two projects are schedule for commissioning in 2020. One project has been commissioned and handed over to the client organisation successfully.

4.4. Data Collection: Interviews

Three primary types of data collection (survey) methods have been identified these include: personal interviewing, telephone interviewing, self-administered questionnaires/surveys (Watkins, 2008). In this research study self-administered questionnaires served as the primary data collection method. *'Interviews are associated with both positivist and phenomenological methodologies'* (Watkins, 2008: 68). In this data collection exercise, Participants were asked questions, in order to determine what they think or feel. The use of personal interviews as an additional element to the data collection process is important. This allows for the identification of issues within the nuclear power plant, which may not be readily identifiable using a pure survey questionnaire.

No of Participants	Self-administered surveys	Interviewed Participants	Participants interviewed telephonically
20	20	14	6

Table 5: Summary of data collection

It is evident that the nuclear power plant has a formal PLCM process to manage projects. However, the PLM process has to be followed and implemented by the responsible Project Managers with the involvement of various stakeholders from various groups. Human risk factors may impact the project performance and Eskom's objectives. In order to evaluate the effective implementation of the stage-gates reviews, interviews were conducted with Project Managers in the nuclear power plant. A structured questionnaire was used to guide the interviews (Appendix B).

4.5. Sample Frame

The research Participants include: Project Managers, Programme Management Officers, senior managers and 20 qualified for the interview. The interview questionnaire consists of 12 questions and the average time for the interview was 30 minutes. Based on the responses from the selected Project Managers, follow-up enquiries were conducted in order to get more clarity so as that the information can be analysed effectively. Fourteen interviews were conducted successfully. Although this is a relatively small sample from which to generalise findings, this number does fit within the guidelines established by (Eisenhardt, 1989) who recommends a sample of between 4 and 12 for in-depth qualitative case studies.

Table 6 depicts the different designations of the respondents to the questionnaire whom offered different perspectives of the value of project stage-gates within a nuclear power plant. Table 6 also depicts the response rate of the 20 questionnaire respondents that were identified for this research study.

Designation	Number of participants
Project Manager (Project Planning Section)	2
Project Manager (Project Development Section)	5
Project Manager (Project Execution Section)	8
Project Manager (Project Construction Section)	3
Senior Manager (Other)	2
Total	20

Table 6: Stakeholders who responded to questionnaire

4.5.1.Participating Individuals

The Researcher approached various groups within the nuclear power plant including the Project Management Office, Mechanical, Civil, Electrical group and Senior Managers which are regarded as the gate keepers in the stage-gate review process. The Researcher considered Project Managers at various levels such as Project planning managers, Project Leaders, Project Managers and Senior Managers from various groups within the nuclear power plant.

The individuals that participated in this research were first invited through email and telephone conversations. Subsequent communication was through emails in which, the information sheet and consent form and the cover letter (see Appendix E and Appendix F) were sent and appointments for interviews were made. Before the interview started the Researcher explained to all Participants what the research study was about and what it seeks to achieve. At that moment the information sheet and consent form was signed by the participant and the researcher (see Appendix E for signed letters). The names of the participating individuals will not be disclosed for confidentiality purposes.

Questionnaire / Interview administered	Number of responses (Questionnaire)	Number of responses (Interview)
Completed	16	14
Partially Completed	2	2
Abandoned	2	2
Total	**20**	**18**

Table 7: Response rating

The Participant's responses have been captured in Appendix C. The participants that were interviewed have more than 10 years each of project management

experience each in the nuclear power plant. From the responses above it is evident that the Project Managers of the nuclear power plant understand the definition/description of the stage-gate review process, performing stage-gate reviews, stage-gate purpose, and the drivers of the stage-gate process. However, some Project Managers are not clear about the benefits of the stage-gate review process as they have highlighted that stage-gate reviews delays their projects, they claim there is too much paper work involved, and they also claim there are many changes in the stage-gate checklist templates. Project Managers have highlighted problems associated with the use of the stage-gate review process which include "*The managers don't check or verify the evidence, the checklist templates changes all the time and this affects project progress, project delays and cost overruns"; "Lack of commitment from the project stakeholders. Incomplete packages from the previous project phase"; "Not enough information documented – can't perform a proper review due to missing information or knowledgeable staff and there is "No ownership by team members – role clarity was not done upfront therefore confusion".*

4.5.2. Impact of not conducting stage-gate reviews

During the interviews with the respective Project Managers it was highlighted that the impact of not conducting stage-gate reviews results in "*delays in the subsequent gates, which might increase the risk of time and cost of the project".* The impact *"Could be significant, depending on the performance of the project team".* Some Project Managers have highlighted that the impact of not conducting stage-gate reviews can result in "*cost overruns and scope creep. It was indicated that there is "Difficulty in closing out the project administratively and contractually; difficulty in handing over the project to the Client because of the incomplete quality assurance data package".*

4.5.3. Stage-gate benefits

It was pointed out that *"Benefits are evaluated most often at the start of the project".* Stage-gate benefits are an *"Indication of project performance against standards". It is also an "Opportunity to make strategic changes to the project and confidence to project team and management that the project is on track to meet the mandate given".* Some of the Project Managers are of the view that

"Feasibility is determined during the development phases and benefits are evaluated at the end of execution phase or even later". It was highlighted that *"Stage-gate reviews are beneficial when we make decisions on the continuance of a project after a feasibility study. It is beneficial to an organization in terms of planning and/or budgeting for a particular project. It aids the organization and team in the planning process going forward on a project initiative".*

4.5.4. Is the implementation of the stage-gate effective

Below is the summary of the Project Manager's responses (18 Project Managers responded to this question) and these responses have been shown in the form of a graph see figure 9 below.

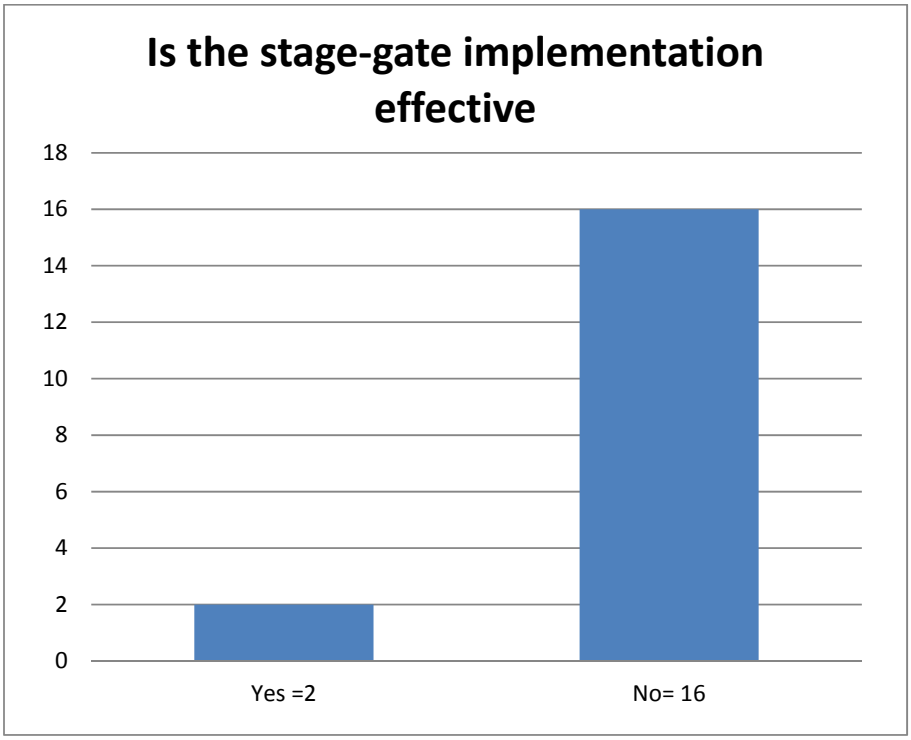


Figure 9: Is the stage-gate implementation effective

Figure 9 shows that the total number of Participants which was 18. Sixteen Project Managers are of the view that the stage-gate implementation is not effective and most of these Project Managers are from the project execution and project construction sections. Two Participants are of the view that the stage-gate implementation is effective. During the interview with these Project Managers they elaborated that the implementation of the stage-gate review process is not effective for the following reasons:

- Currently it is in the form of a check-list, which can easily be manipulated to give a positive result. So your effectiveness is dependent on the quality of the check-list
- "No unless the reviewers insist on verifying the evidence"
- No clear ownership of and accountability for this process
- Not everyone was trained on this process
- No clear communication to relevant staff
- Stage-gate template/checklist keep changing and this delayed the project progress

- It looks good on paper that the PLCM but the implementation is not user friendly.

Two Project Managers from the project development section believe that the stage-gate review process is effective because of the following reasons:

- *"Yes, it allows one to move with confidence to the next stage of the project. On the other hand, it also lengthens the duration and in turn add to the cost of time on the project"*
- *"Yes, because project packages are completed at the end of each project phase"*

4.5.5. Stage-gate Effectiveness

Some Project Managers have pointed out that the stage-gate review process is not effective because *it "delays project progress and communication is not effective"* Participant number 1, Appendix C. It is *"currently in the form of a checklist, which can easily be manipulated to give a positive result therefore your effectiveness, is dependent on the quality of the check-list"* Participant number 2, Appendix C. In addition to the above reasons, the Project Managers have highlighted that "*Stage-gate reviews are effective in term of project readiness; on the other hand it can become lengthy and in turn add to the cost of time on the project"* Participant number 3, Appendix C.

Generally, the nuclear project management personnel have good understanding of the following stage-gate review definition/description; performing stage-gate reviews; purpose of the stage-gate and stage-gate drivers. However, this research study revealed that there are some gaps and little understanding regarding the benefits of the stage-gate review process; impact of not conducting stage-gate reviews; current stage-gate challenges; implementation of the stage-gate review process; stage-gate effectiveness and stage-gate monitoring.

4.5.6. Stage-gate drivers

Figure 10 indicates who the stage-gate drivers are. Seven Participants believe that the Project Management Office is responsible for driving the stage-gate review process. Four Participants believe that Project Managers are the stage-

gate drivers. Three Participants are of the view that senior managers are responsible for driving the stage-gate review process. Only two Participants are of the view that Project Managers, the Project Management Office and Senior Managers are responsible for driving the stage-gate review process. The literature suggests that Senior Managers act as "gatekeepers", and they manage the stage-gates and they have the authority to approve the resources needed by the project (Cooper, 1990).

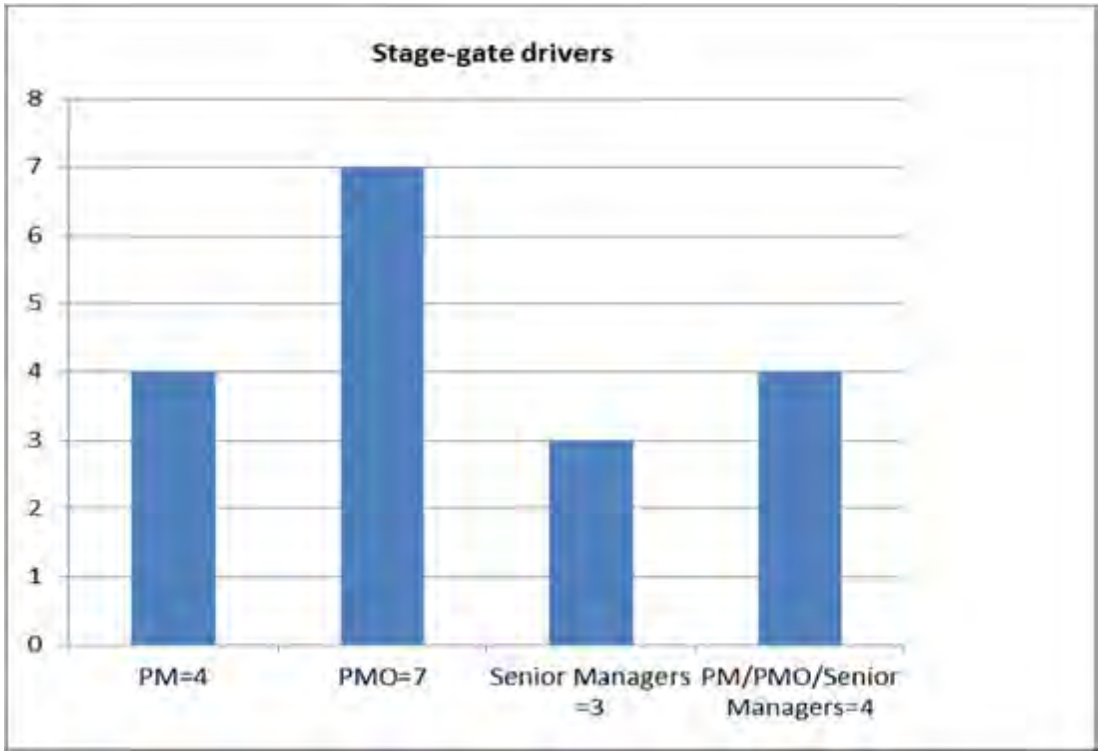


Figure 10: Stage-gate drivers

4.5.7. Stage-gate monitoring

Figure 11 shows number of responses of the Participants which participated in this research study. In summary ten Project Managers from the execution section have indicated that it is not clear who monitors the stage-gate review process and how often are the stage-gate review process monitored. The Project Managers from the project development section which is also known as Project Management Office and the Senior Management have a similar understanding that *Project Managers are responsible for monitoring the stage-gate review process and this is done at the end of the each project phase. There are trained*

PMO assessors who perform an oversight role by verifying information submitted by Project Managers.

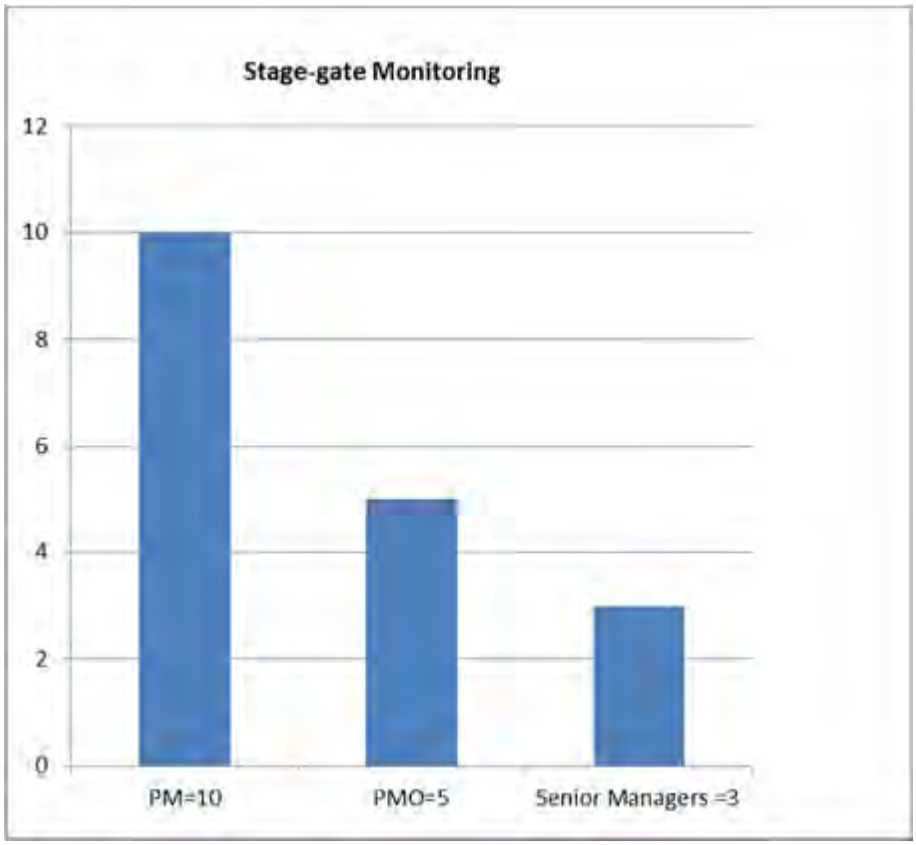


Figure 11: Stage-gate monitoring

Figure 11 shows the responses of the Participants which were interviewed. Project Managers have indicated that it is not clear who monitors the stage-gate review process and also the monitoring frequency is not clear either. Below is the summary of the project manager's responses (from the execution section).

- *Project Management Office is responsible for monitoring and not sure how often*
- *Management Review Committee is responsible for monitoring and not sure how often*
- *Not sure*
- *Not clear who monitors and not sure how often*
- *Project Management Office is responsible for monitoring and not sure how often*

- *Project quality advisors should monitor the stage-gate review process*
- *Project Management Office facilitator.*

Project Managers (Project Planning Section) responses – summary in their own words

- *Project Managers are responsible for monitoring the stage-gate review process*
- *There are trained PMO assessors or monitors who verify information submitted by PM and this is done at the end of each project stage. These assessors perform an oversight role*

Senior Managers responses (Summary)

- *Project Managers are responsible for monitoring the stage-gate review process and this is done at the end of the each project phase*
- *There are trained PMO assessors who perform an oversight role by verifying information submitted by Project Managers.*

4.6. The value of the stage-gate review process in projects

This point was covered in detail during interviews with respective Project Managers. The value of the stage-gate review process has been pointed out in section 4.3.2 – project "B" category. Some Project Managers have highlighted that they strive to consistently deliver projects that address client needs cost effectively while achieving reliability, quality, safety, and minimise risk. However, they have not been able to achieve their project goals successfully hence the stage-gate review process has been introduced into the organisation. The implementation of the stage-gate review process has optimised risk, cost and quality. Some Project Managers see the stage-gate review process as a method for managing project risk and cost within a structured process. Some of the benefits of making use of the stage-gate review process are:

- Project documentation is monitored at each phase (prior proceeding to the next phase)
- Prevention of cost overruns
- Poor quality is prevented and if it occurs it is addressed immediately
- No scope creep

- Project information is easily retrievable and accessible
- Increased better quality and better overall project performance compared to informal processes that was used in the past
- Provide a “road map” for the project leader and team. The project team members, often come from different departments within the organisation, they have different disciplines. The process is standardised and this benefits the organisation. This is supported in the literature, a stage-gate system when executing a project it provides the whole project team a clearer idea of how the project is progressing, where it is going, and what needs to be done before moving to the next project phase (Cooper, 1990)
- Project close out is manageable
- Projects are handed over to the Client on required time
- Business Realisation is performed adequately by the client and project management organisation. This is done technically and financially
- Project traceability is no longer an issue
- Configuration management is no longer a challenge.

The value of the stage-gate review process pointed out by some of the Project Managers is in line with the literature review that has been covered in chapter two, section 2.10.

4.7. Conclusions

The data analysis done in this chapter, shows that there is a general understanding of what the stage-gate review process is; when stage-gate reviews are performed; the purpose of the stage-gate, and stage-gate drivers. However, this research study revealed that there are some gaps and little understanding regarding the benefits of the stage-gate review process; the impact of not conducting stage-gate reviews; and most Project Managers are of the view that the implementation of the stage-gate review process is not effective. It is not known who monitors the stage-gate review process and how often the stage-gate review process is monitored.

The next chapter chapter will give the conclusions of this research study by giving recommendations and pointing out areas that may need to be improved in the future in this field of study.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Introduction

This chapter will draw conclusions to this research study by explaining and outlining whether the findings analysed in the previous chapter have addressed and answered the research questions identified in chapter 1. A literature review has been performed in order to analyse the existing information related to the application and importance of stage-gate reviews in the project management field. A methodology presented in chapter 3 was developed for the research using a case study strategy. This chapter will outline whether the objectives and aims of this research study were achieved. It will conclude by giving recommendations and suggestions for areas of improvement.

5.2. Problem Statement Revisited

The problem statement in this research study was defined in chapter 1 as:

"The stage-gate review process is not used by some projects that are mandated to do so".

The unit of analysis for this research study were both "group A projects" and "group B projects". Group A projects were implemented prior the use of the stage-gate review process. Ten projects from group A project category were reviewed. Out of the ten projects that were reviewed, the project management organisation was able to hand over three projects to the client organisation successfully. The remainder were not handed over due to the problems that were experienced during the commissioning of these projects. The problems experienced were associated with: cost overruns, scope creep, poor quality work, incomplete Quality Assurance Data Package (QADP) and incomplete project information on the Project Managers file.

Group B projects were projects performed under the governance of the stage-gate review process. Five projects under the governance of the stage-gate review process were reviewed. Two of these projects are scheduled for

commissioning when there is a maintenance shutdown beginning of 2017 and the other two projects are schedule for commissioning in 2019. One project has been commissioned and handed over to the client organisation successfully.

The findings of this research study shows that a there is a general understanding of what the stage-gate review process is; when stage-gate reviews are performed; the purpose of the stage-gate and stage-gate drivers. There is a lack of understanding of the benefits and use of the stage-gate review process in all projects. The finding has shown that some Project Managers are of the view that the implementation of the stage-gate review process is not effective. It is not known who monitors the stage-gate review process nor how often the stage-gate review process is monitored.

5.3. Research Question Revisited

The research question in this research study was defined in chapter 1 as:

What value does the stage-gate review process add to projects in the power plant?

This research question has been addressed during interviews with respective research Participants. The findings of this research study shows that the organisation benefits from the use of the stage-gate review process and this has been pointed out in section 4.5. However, there are still some gaps in the project execution section as the Project Managers are still of the view that the stage-gate review process is a paper exercise, it delays their project progress, there is too much bureaucracy and the checklist template keeps changing.

The sub-questions to be researched in support of the research question are as follows:

- Who drives the stage-gate review process?
- What value is obtained from the stage-gate review process?
- Who gains value from the stage-gate review process?
- What is the impact of not conducting PLCM stage-gate reviews?

The next section is going to outline whether these sub-questions were addressed and answered by the findings of this research study.

5.3.1. Who drives the stage-gate review process?

In the literature as discussed in chapter two, Senior Managers act as "gatekeepers" and they manage the stage-gates and have the authority to approve the resources needed by the project. More importantly, gatekeepers have more and broader experience and bring useful insights to the project (Cooper, 1990). At each stage-gate, gatekeepers use a defined criteria to determine whether they should continue (go) or (kill) the projects, (Leithold *et al.*, 2015).

This research study revealed that Project Managers have a common understanding of the stage-gate drivers. However, there is still some emphasis required with regard to stage-gate drivers as the majority of participants are of the view that the Project Management Office is the stage-gate driver (see Figure 10 chapter 4). Seven Participants believe that Project Management Office is responsible for driving the stage-gate review process. The Programme Management Office will be the central custodian of the standard Eskom Project Life Cycle Model (PLCM) and will coordinate and approve the project life cycle models defined for specific project types, ensuring they align to the standard Eskom PLCM. The Programme Management Office will be accountable for the maintenance and issuing of regular updates to the standard Eskom PLCM to keep the model current with best practice and improvements as they are identified (Eskom, 2013).

5.3.2. The value obtained from the stage-gate review process?

Chapter 2 section 2.8 presented some advantages of a stage-gate review process.

The findings of this research study showed some of the benefits of making use of the stage-gate review process see section 4.5.

During interviews with some of the Participants, it was highlighted that the use of the stage-gate review process increases project quality, reduces project cost and

project risk to a minimal. Furthermore, the project management organisation is able to handover projects on time and at the required time to the client organisation because the projects are closed administratively and contractually with no challenges and there are no problems associated with the quality data packages documentation. Also benefit realization is done both technically and financially with the challenges as the stage-gate review checklist is used in each project phase.

5.3.3. The value gained from the stage-gate review process?

The section has been covered in detail chapter two. The stage-gate review process is a system that is essential for managing the new product process to improve business effectiveness and efficiency (Cooper, 1990).

The value gained from the stage-gate review process is that the risk is kept at minimum and project performance is improved and the project quality delivered is satisfactory and meets the set project requirements. Furthermore, organisations gain from using stage-gate review process. For instance the nuclear power plant gains or benefit from using the stage-gate review process and these benefits have been highlighted in section 4.5 - the value of the stage-gate review process in projects.

5.3.4. What is the impact of not conducting PLCM stage-gate reviews?

The findings of this research study confirmed some of the benefits claimed from of making use of the stage-gate review process and this has been covered in detail in section 4.5 above.

The group “A” project categories (refer to section 4.3.1) were initiated prior the use of the stage-gate review process. Though a procedure for managing projects in the nuclear power plant was followed from the start of the project until the project close out there were some problems associated with the impact of not conducting stage-gate reviews. For instance cost overruns, scope creep, poor quality work, problems related to configuration control, project handover was problematic because of Quality Assurance Data Package (QADP) which were incomplete. Section 4.3.1 above has covered this in detail.

During the interviews with the respective Project Managers it was highlighted that the impact of not conducting stage-gate reviews results in "*delays in the subsequent gates, which might increase the risk of time and cost of the project".* The impact of not conducting stage-gate reviews *"Could be significant or not, depending on the performance of the project team".* Some Project Managers have highlighted that the impact of not conducting stage-gate reviews can result in "*cost overruns and scope creep. It was indicated that there is "Difficulty in closing out the project administratively and contractually; difficulty in handing over the project to the Client because of the incomplete quality assurance data package".*

5.4. FULFILMENT OF AIMS AND RESEARCH OBJECTIVES

To return to what was discussed in chapter one, the aim of this research study was to identify areas for improvement within the stage-gate process. Table 8 provide a detailed summary of the research aims, research questions, research objectives, research methodology and research results. The findings of this research study showed some of the benefits of making use of the stage-gate review process and this has been covered in detail in section 4.5 above. Table 8 below shows the research results in detail.

In the literature the purpose of the stage-gate review process has been covered which is to identify non-conformances early enough in order to ensure that resources are assigned to the project and more support is provided where necessary (Kerzner, 2006). Also the stage-gate benefits have been covered in detail and some of them include: building in quality control checkpoints in the form of gates (Cooper, 1990); ensuring that projects that are not relevant to the business strategy can be terminated at any stage (Nicholas and Steyn, 2012). The findings show that there is some resistance from the execution Project Managers in implementing the stage-gate review process and also make it part of the business processes. However, the Project Managers of the development section are satisfied with methods and processes that govern the stage-gate process and they believe that the use of the stage-gate review process benefits all the project stakeholders including the organisation and the quality of project

performance is improved. This research study has revealed that training of personnel on the stage-gate review process is required; communication of the stage-gate review policy, roles and responsibility needs to be addressed. Furthermore, change management initiatives needs to be initiated in order to address stage-gate review key issues and also improve project performance. Change management training is also required to ensure that changes are thoroughly and smoothly implemented, and that the lasting benefits of change are achieved.

Research Aims	Research Questions	Research Objectives	Research Methodology	Research Results
Establishing who is responsible for stage-gate effective implementation	Who drives the stage-gate review process?	Determine who drives the stage-gate review process	A Qualitative methodology has been used in this research study	Seven participants believe that Project Management Office is responsible for driving the stage-gate review process. Four participants believe that Project Managers are the stage-gate drivers. Three participants are of the view that senior managers are responsible for driving the stage-gate review process. Two participants are of the view that project managers, Project Management Office and Senior Managers are responsible for driving the stage-gate review process
Establishing the value of the stage-gate process	What value is obtained from the stage-gate review process?	Establish what value is obtained from the stage-gate review process	A Qualitative methodology has been used in this research study	Chapter 2 section 2.8 presented some advantages of a stage-gate review process. The findings of this research study showed some of the benefits of making use of the stage-gate review process and this has been covered in detail in section 4.5 above.
Identifying the value obtained from the stage-gate reviews	Who gains value from the stage-gate review process?	Determine who gains from the stage-gate review process	A questionnaire and interviews have been conducted	The research findings revealed that the power plant gains or benefit from using the stage-gate review process and these benefits have been highlighted in section 4.5 - the value of the stage-gate review process in projects. This is supported by (Phillips *et al.*, 1999; Claggett and Eklund, 2005) in section 2.6.1.
Evaluating the impact of not conducting stage-gate reviews and identifying areas for improvement	What is the impact of not conducting PLCM stage-gate reviews?	Determine the impact of not conducting PLCM stage-gate reviews		During interviews, Project Manager have responded (it's in their own words) on the impact of not conducting stage-gate reviews. *"This will result in delays in the subsequent gates, which might increase the risk of time and cost of the project".* *"Could be significant or not, depending on the*

				performance of the project team" *"Cost overruns, scope creep".* *"Difficulty in closing out the project administratively and contractually".* *"Difficulty in handing over the project to the Client. Incomplete quality assurance data package".*

Table 8: Research aims, research objectives and research questions

5.5. RECOMMENDATIONS AND AREAS FOR IMPROVEMENT

The evidence of the findings suggests that there is reliance in implementing the stage-gate review process in projects. This research study makes the following recommendations:

- A compulsory on job and classroom training of the all the Project Managers. More focus should be on the execution section, an action to train Project Managers has to be developed and a roster needs to be sent out to all the Project Managers that should be trained
- Link the performance management of the project management personnel to the stage-gate review process
- The stage-gate process should be a standing discussion item at departmental work team sessions
- Some clarity in the form of a training session is required to address this matter of stage-gate drivers so that a common understanding can be established in the aid of the effective implementation of the stage-gate review process.
- The stage-gate process should form part of the induction programme for NPM employees
- There is a need for future research to look at how does the stage-gate review process is represented and implemented in projects of short duration.

5.6. CONCLUSIONS

In final remarks, the research carried out in this study has provided evidence of what value the stage-gate review process adds to the organisation and the benefits that arise from this process. The evidence shows that the stage-gate review process has been implemented but it is not effective. There is an opportunity for the stage-gate review process to be re-inforced in order to improve project quality performance and increase productivity through promoting the effective implementation of the stage-gate review process.

The stage-gate review process has been researched by Cooper (Cooper, 1990). It has evolved from a development environment where the time frame is relatively large. The amount of time to do stage-gate reviews in the nuclear power plant environment is the same as that of a new product development environment.

For future research, the question arises, does the stage-gate review process represent too great demand on time and resources in projects of short duration in a time critical environment.

Several Project Managers are of the view that the stage-gate review process takes up too much of their time. The stage-gate review process came from the Research and Development environment where projects have relatively long durations compared to the operations at the nuclear power plant.

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APPENDIX A: RESEARCH ENVIRONMENT

Motivation for Selecting a Case Study

Eskom is a company which generates, transmits and distributes 95% of electricity in South Africa and 45% used electricity to Africa (Eskom, 2013). Eskom supplies electricity to industrial, mining, commercial, agricultural and residential customers and redistributors. It has various divisions such as Generation, Transmission, Distribution and Group Capital.

The research project is conducted in the Generation division at Koeberg Operating Unit in the Nuclear Project Management Department. Koeberg ensures a reliable supply of electricity to the Western Cape, which is one of the fastest growing regions in South Africa. It has operated safely for more than 30 year. The stations' two reactors supply 1 800MW or 6% of South Africa's electricity needs. The Nuclear Project Management (NPM) Department manages the modifications raised by System Engineers to deal with plant problems that can pose threat to the plant. System Engineers are system owners who have the following responsibilities:

- Identification of problems and initiate the modifications which are need to be fixed,
- Compilation of the statement of work
- Provides technical support to the project team
- Support Project Managers in approval process or effectiveness review.

The NPM department is divided into several groups including Quality Management, Contracts Management, Electrical, Mechanical and Construction.

The modifications are raised and are accepted by the project team. The NPM Manager delegates projects to the relevant group based on the type of the project and expertise of the Project Manager. A Project Manager gets allocated for a modification and has the overall responsibility for the successful initiation, planning, design, execution, monitoring, controlling and closure of a project.

The Nuclear Project Management Department (NPM) has been tasked with implementing modifications and projects; hence it is the subject of this research. To this end, the mandate of NPM is to develop, manage, execute and monitor projects

on behalf of the power plant in accordance with its management processes regarding time, budget, scope, quality, safety, health and environment. They are also the custodian of the Nuclear Technical Plan/Business Plan (NTP). NPM has the responsibilities to:

- Provide project management services for the projects and modifications
- Develop and maintain standards for nuclear projects
- Minimise outage duration through optimised project plans and production planning, which include close interfaces with Plant Management and, in particular, Outage Management
- Develop and manage operational, strategic engineering, safety and long term asset management projects for power plant. The term “develop” implies that the client/project requestor has a clear problem statement or need (acceptance criteria), and participates through the assignment of key staff in the development of this need into a project concept and scope. The term “manage” implies that on receipt or approval of an approved technical requirement specification, NPM is the responsible lead for implementation
- Manage project engineering and specialist services or subject matter experts who are seconded from Engineering or other departments;
- Provide the function of strategic and detailed planning, scheduling and control of all modifications and projects within the department as well as interfacing with the power plant, Finance and Commercial departments, to agreed milestones
- Provide the function of project management, quality control and quality assurance of the project lifecycle
- Manage the training and development of Project Managers for nuclear projects
- Support the Nuclear Centre of Excellence (CoE) to develop the project execution plan for the client office. This includes scoping, planning, costing and execution of the owner’s scope
- Monitor and report on configuration control for project document changes
- Establish links with Eskom’s CoE for Project Management; and

- Conduct project review readiness assessments for nuclear projects.

The NPM department has been selected as a case study in this project because it uses the stage-gate review process when managing projects.

The case study approach has been chosen for this research project for the following reasons:

- The nuclear power plant has a clear goal, vision and objectives to provide electricity its customers
- The nuclear power plant has established and maintained the nuclear safety culture and it adheres to stringent processes which are implemented to ensure public safety and health
- The nuclear power plant is the only nuclear power station on the African continent
- The electricity production has an impact on the public
- The nuclear power plant plays a major role towards the society and environment

Based on the above reasons, it is clear that NPM Project Managers should be well vested in utilising stage-gate reviews in ensuring that the vision of producing world class nuclear energy and also ensuring that the public safety is accomplished. In summary NPM is found to be the best department to perform this research study (survey).

APPENDIX B: DOCUMENT REVIEW

Background information on documentation review

The nuclear power plant follows a structured approach when managing projects, standards and policies are used for project management. Corporate standards are then cascaded to the operational levels of the business. In this way, the nuclear power plant ensures that projects are managed in accordance with the set standards and also project requirements and specifications are met. Project management responsibility rests within the Line Managers and Project Managers of the nuclear power plant. The responsible managers must also make sure that appropriate and effective controls exist at all times.

During the past five years, the nuclear power plant embarked on a project called Back2Basics which aimed at standardising, simplifying and optimising processes within the organisation. Currently, the nuclear power plant makes use of the Project Life Cycle Model (PLCM) and the following phases are used during the project life cycle: Conception Release Approval (CRA), Definition Release Approval (DRA), Execution Release Approval (ERA) and Finalisation Release Approval (FRA).

Prior the start of a project, an opportunity gets reviewed; the Statement of Work (SOW) or User Requirement Specification (URS) are compiled during the Pre-Planning phase. Root Cause Analysis, Pre-Schedule Plan, High Level Cost Plan aligned to Schedule, High Level Scope Statement of Work, High Level Resource Role Plan, Risk Ranking and Pre-CRA checklist are also considered at this stage.
Table 9 below shows documents that were prepared during each the selected project phases.

Pre-Project Planning (Pre – CRA)	Concept Phase (CRA)	Definition Phase (Feasibility)
User Requirements Specification	Pre-Feasibility Study Report	Detailed design
Project Charter	Concept Design	final Technical Requirement Specification is
Scope Statement	DRA Checklist	Updated Project Management Plan
Project Management Plan (PMP)	Investment Committee (IC) Documents	Updated Human Resource Plan Updated Schedule Plan
Level 1 Schedule Plan (high level plan)	IC DRA Form	Financial & Funding Plan
Cost Breakdown Structure (CBS)	IC Presentation	Quality Plan
Risk Assessment Plan	IC Checklist	Risk Management Plan
Resource Plan	Updated PMP	Communication Plan
CRA Checklist	Cost Breakdown Structure (CBS)	Stakeholder Plan.
Investment Committee (IC) Documents	Risk Management Plan	Commercial Strategy
IC CRA form	Resource Management Plan	Contracting Strategy
IC Checklist and a prepared power point presentation	Updated Schedule Plan	

Table 9: Project Phases

The document review covers some projects that were implemented prior the use of the stage-gate review process. It also includes projects that started after the stage-gate review process was implemented. The use of the stage-gate review process referred to as “group A project” and projects performed that falls under the governance of the stage-gate review process and are referred to as “group B project”. The unit of analysis for this research study were both “group A project” and “group B project”.

APPENDIX C: REMARKS FROM PARTICIPANTS

Remarks from Participant 1

Below are some of the participant's responses

Stage-gate review definition/description: A checklist that assist to review that all activities associated with a project phase are completed before entering a new phase.

Performing stage-gate reviews: When the project phase is completed before entering a new phase

Stage-gate purpose: Verify that all the previous phase requirements are met

Stage-gate benefits: Reminds the Project Manager for items that may have been forgotten

Stage-gate drivers: Project Managers

Stage-gate impact: None, unless if I have forgotten certain items

Current stage-gate challenges: The managers don't check the check or verify the evidence

Stage-gate benefits: At the end stage (handover/decommissioning) of a project

Stage-gate implementation: No unless the reviewers insist on verifying the evidence

Stage-gate Effectiveness: Not effective because it delays project progress and communication is not effective

Stage-gate monitoring: By ensuring that the checklist is signed before an investment document is approved. Not sure who monitors it.

Remarks from Participant 2

Stage-gate review definition/description: It is the process by when the project team or independent role-players follow a prescribed assessment method to determine the performance of the project to date and the readiness for the next phase.

Performing stage-gate reviews: Normally this would be performed at the end of a specific project phase eg development phase.

Stage-gate purpose: To determine the performance of the project to date and the readiness for the next phase

Stage-gate benefits: Indication of project performance against standards; opportunity to make strategic changes to the project; confidence to project team and management that the project is on track to meet the mandate given

Stage-gate drivers: Project life cycle management custodians ie. Project Management Office and Management

Stage-gate impact: Could be significant or not, depending on the performance of the project team

Current stage-gate challenges: Not enough information documented – can't perform a proper review due to missing information or knowledgeable staff. No ownership by team members – role clarity was not done upfront therefore confusion

Stage-gate benefits: Feasibility is determined during the development phases and benefits are evaluated at the end of execution phase or even later

Stage-gate implementation: No. Currently it is in the form of a check-list, which can easily be manipulated to give a positive result. So your effectiveness is dependent on the quality of the check-list

Stage-gate Effectiveness: Not very as stated above

Stage-gate monitoring: It gets reviewed by PMO and oversight committees like Management Review Committee. NPMO, Not sure how often.

Remarks from Participant 3

Stage-gate review definition/description:

It is basically a project management technique in which a project is divided into (i.e. stages).

Performing stage-gate reviews: It is performed at the early stages of project development and is beneficial for making decisions regarding continuance of a project in the case of project management. The continuance or readiness to move from stage-gate (1) to the next stage-gate (2) will normally depend on a committee or manager.

Stage-gate purpose: I believe it is all about readiness of a project to move from stage-gate to the next / high level stage-gate. Stage-gate reviews stimulate communication, identify any risks to project success and provide mitigating action plans to improve those areas needing attention.

Stage-gate benefits: Stage-gate reviews are beneficial when we make decisions on the continuance of a project after a feasibility study. It is beneficial to an organization in terms of planning and/or budgeting for a particular project. It aids the organization and team in the planning process going forward on a project initiative.

Stage-gate drivers: In our organization we have our Eskom Project Management Office (EPMO) facilitator. The EPMO has various scoring and maturity expectations at each stage-gate review(s). EPMO performs this systematically in order to meet the project objectives and improve long-term results.

Stage-gate impact: This will result in delays in the subsequent gates, which might increase the risk of time and cost of the project.

Current stage-gate challenges: Once the availability of a facilitation team has been confirmed, the Project Manager is responsible for arranging the meeting and inviting the required stakeholders. Project team is not always available for reviews.

Adequate attendance by the project team is therefore required. All relevant key discipline leads should be represented to ensure success.

Stage-gate benefits: Most often at the start of the Project.

Stage-gate implementation: Yes, it allows one to move with confidence to the next stage of the project. On the other hand, it also lengthens the duration and in turn add to the cost of time on the project.

Stage-gate Effectiveness: Stage-gate reviews are effective in term of readiness. On the

other hand, it can become lengthy and in turn add to the cost of time on the project.

Stage-gate monitoring: To my knowledge stage-gate reviews are monitored regularly preceding approval. In our organization we have our Eskom Project Management Office (EPMO) facilitator. The EPMO has various scoring and maturity expectations at each stage-gate review(s). However, the Project Manager is responsible for arranging the meeting and inviting the required stakeholders.

Remarks from Participant 4

Stage-gate review definition/description: Is the process of ensuring that the stage gate actions have been achieved and to obtain authorization to proceed to the next stage.

Performing stage-gate reviews: Normally this would be performed at the end of a specific project phase eg development phase. After the project have been approved by the committee to go ahead

Stage-gate purpose: Is to evaluate if the project is feasible and if yes it ensures that all the necessary steps are taken to complete the project successfully by signing off the completed stage and authorizing the next one.

Stage-gate benefits: To ensure that all the activities are met and to give authorization to proceed to the next stage.

Stage-gate drivers: The initiator and once the project have been accepted as the project then the Project Managers takes over.

Stage-gate impact: Could be significant or not, depending on the performance of the project team

Current stage-gate challenges: Not enough information documented – can't perform a proper review due to missing information or knowledgeable staff. No ownership by team members – role clarity was not done upfront therefore confusion

Stage-gate benefits: During the review opportunity the initiator present to the committee what value will the project add to the organization and that has to be accepted and approved. At the end of the project the benefits of the project must be assessed.

Stage-gate implementation: No. Currently it is in the form of a check-list, it looks good on paper.

Stage-gate Effectiveness: Not effective, looks good on paper

Stage-gate monitoring: Not sure. I assume when one stage is complete and the project must move to the next phase.

APPENDIX D: RESEARCH INTERVIEW QUESTIONS

Date		
Interviewee		
Role in the Organisation		

Note

- *The purpose of the research and the reason for conducting this interview will be explained to each interviewee.*
- *This interview is anonymous whereby the interviewee's name will not be mentioned or recorded as part of the interview.*
- *The structure and duration of the interview will be explained to the interviewee.*
- *The interviewee will be prompted to ask any questions to clarify matters discussed.*
- *The interviewee will be asked for her/his consent to conduct the interview based on the information relating to the research which has just been shared. The information shared by the interviewee will remain confidential, and only the interviewer will have access to it.*
- *The notes will be destroyed after the submission of the research project to UCT.*

	Stage-gate review definition/description
1.	What is the stage-gate review process?
	Performing stage-gate reviews
2.	When is the stage-gate process performed?
	Stage-gate purpose
3.	In your view, What is the purpose of the stage-gate reviews?
	Stage-gate benefits
4.	What are the benefits that you experience in the stage-gate reviews?
	Stage-gate drivers
5.	Who are the drivers of the stage-gate review process in your organization?
	Stage-gate impact
6.	What is the impact on your project if stage gate reviews are not performed?
	Current stage-gate challenges
7.	What are the current problems that you encountered during the stage-gate review process? Please explain
	Stage-gate benefits

8.	When are the project benefits evaluated in your organisation? e.g at the beginning of the project, at every stage during the lifecycle of a project, well after the completion of the project, at the end stage (handover/decommissioning) of a project
	Stage-gate implementation
9.	In your view, Is the implementation of the stage-gate reviews effective? Please explain
10.	In your view, how effective and efficient are the stage-gate reviews?
	Stage-gate monitoring
11.	How is the stage-gate review process monitored in your projects?
12.	Who monitors the stage-gate review process in your organisation and how often is it monitored?

APPENDIX E: INFORMATION SHEET & CONSENT FORM

University of Cape Town

INFORMATION SHEET & CONSENT FORM

A Study of the Value of Project Stage-Gates within a Nuclear Power Plant

Good day,

My name is Nomfusi Gumede and I am conducting research towards a Masters in Project Management. I am conducting a study on the Value of Project Stage-Gates within a Nuclear Power nuclear power plant and would like to invite you to participate in this research project.

The purpose of the research

The purpose of this research study is to establish what value is obtained from the stage-gate review process. It seeks to determine drivers of the stage-gate review process and also determine the impact of not conducting Project Life Cycle Model (PLCM) stage-gate reviews during project phases.

The data collected from the interviews, will be treated with utmost confidentially, the source of which will only be known to the Researcher. To emphasise the anonymity of your participation, you will be referred to as 'Participant A' or 'Participants B' in the research report. A copy of the findings can be provided to you for scrutiny by your organisation should you deem this necessary and should you so wish. Interviews for case studies will be treated as confidential. The project names and interviewee names will be not disclosed. The data will be collected by means of questionnaire and interviews. The interviewees will be PLCM stakeholders such as: project leaders, Project Managers, programme managers and senior managers. The

Researcher does not intend to establish new stage-gate review process or PLCM tools and techniques.

Procedure in conducting the research

This research will involve your participation in a 15 to 30 minutes semi-formal interview with an interviewer. Consequently, individual interviews will be conducted with you for the purpose of clarifying information gathered through questionnaires. The interview will be conducted at a place and time of your choice. You have the choice to decline if you do not wish to answer any question asked in this interview. The interviewer will just move on to the next question. The interview will be done in a confidential manner and all questions will be asked in a private setting with only the interviewer present with you, unless if you request another person of your choice to be present. You will be requested to respond to the questionnaire which will be provided to you as part of the research study.

Should you require any information throughout or before the process of completing the questionnaire or during the interview, please feel free to contact or prompt the principle researcher. It is the aim of the principle researcher to conduct the study carefully and thoughtfully, ensuring that the data capturing, display, and analysis processes are completed in such a way that there is no risk involved for the participating organisation.

Please understand that you do not have to participate and that your participation is voluntary. If you choose not to participate, there will be no negative consequence. If you choose to participate, but wish to withdraw at any time, you will be free to do so without negative consequence. However, I would be grateful if you would assist me by allowing me to interview you.

Please note there is no anticipated risk that harm might ensue, all information gathered will be treated with high anonymity. However, if the participant feels uncomfortable to share or elaborate on any information during interviews, the researcher will honour the participant's feelings by terminating the interview session.

Print Name of Participant Signed

Signature of Participant

Date 28/06/2016

APPENDIX E: INFORMATION SHEET & CONSENT FORM

University of Cape Town

A Study of the Value of Project Stage-Gates within a Nuclear Power Utility

Good day,

My name is Nomfusi Gumede and I am conducting research towards a Masters in Project Management. I am conducting a study on the Value of Project Stage-Gates within a Nuclear Power Utility and would like to invite you to participate in this research project.

The purpose of the research

The purpose of this research study is to establish what value is obtained from the stage-gate review process. It seeks to determine drivers of the stage-gate review process and also determine the impact of not conducting Project Life Cycle Model (PLCM) stage-gate reviews during project phases.

The data collected from the interviews, will be treated with utmost confidentially, the source of which will only be known to the Researcher. To emphasise the anonymity of your participation, you will be referred to as 'Participant A' or 'Participants B' in the research report. A copy of the findings can be provided to you for scrutiny by your organisation should you deem this necessary and should you so wish. Interviews for case studies will be treated as confidential. The project names and interviewee names will be not disclosed. The data will be collected by means of questionnaire and interviews. The interviewees will be PLCM stakeholders such as: project leaders, project managers, programme managers and senior managers. The Researcher does not intend to establish new stage-gate review process or PLCM tools and techniques.

Procedure in conducting the Research

This research will involve your participation in a 15 to 30 minutes semi-formal interview with an interviewer. Consequently, individual interviews will be conducted with you for the purpose of clarifying information gathered through questionnaires. The interview will be conducted at a place and time of your choice. You have the choice to decline if you do not wish to answer any question asked in this interview. The interviewer will just move on to the next question. The interview will be done in a confidential manner and all questions will be asked in a private setting with only the interviewer present with you, unless if you request another person of your choice to be present. You will be requested to respond to the questionnaire which will be provided to you as part of the research study.

Should you require any information throughout or before the process of completing the questionnaire or during the interview, please feel free to contact or prompt the principle researcher. It is the aim of the principle researcher to conduct the study carefully and thoughtfully, ensuring that the data capturing, display, and analysis processes are completed in such a way that there is no risk involved for the participating organisation.

Please understand that you do not have to participate and that your participation is voluntary. If you choose not to participate, there will be no negative consequence. If you choose to participate, but wish to withdraw at any time, you will be free to do so without negative consequence. However, I would be grateful if you would assist me by allowing me to interview you.

Please note there is no anticipated risk that harm might ensue, all information gathered will be treated with high anonymity. However, if the participant feels uncomfortable to share or elaborate on any information during interviews, the researcher will honour the participant's feelings by terminating the interview session.

Print Name of Participant _Mashudu Sigama_____Date:

2016-06-24 **Signature of Participant**_ 

APPENDIX F: SUMMARY OF THE RESEARCH STUDY

Dear Sir/Madam

RE: Summary of the Research Study for the Purpose of Ethic Clearance

Research study for 'A Study of the Value of Project Stage-gates Within a Nuclear Power Plant' will be conducted by myself (the researcher) for the purpose of completing a Minor Dissertation towards MSc in Project Management. Questionnaire and interviews will be used to collect research data from the participants.

Ethical Issue

The methodology for collecting research data will makes use of living people within the Koeberg Power Station. As guided by section 1.1.4 of EBE Ethics in Research Handbook, Masters Level and PhD students should complete an application for ethics clearance under the supervisor's guidance and submit it directly to the EiRC.

Therefore, I hereby request for the review of my proposal for ethical issue(s) and thereby an approval of my intention to conduct a research studies on the above stated topic.

Kind Regards,

Nomfusi Gumede

Student Number: GMDNOM012

APPENDIX G: ETHICS APPROVAL

Application for Approval of Ethics in Research (EIR) Projects
Faculty of Engineering and the Built Environment, University of Cape Town

APPLICATION FORM

Please Note:
Any person planning to undertake research in the Faculty of Engineering and the Built Environment (EBE) at the University of Cape Town is required to complete this form ***before*** *collecting or analysing data.The objective of submitting this application prior to embarking on research is to ensure that the highest ethical standards in research, conducted under the auspices of the EBE Faculty, are met. Please ensure that you have read, and understood the* **EBE Ethics in Research Handbook**(available from the UCT EBE, Research Ethics website) prior to completing this application form: http://www.ebe.uct.ac.za/ebe/researchyethics.pdf

APPLICANT'S DETAILS		
Name of principal researcher, student or external applicant		NOMFUSI GUMEDE
Department		CONSTRUCTION ECONOMICS AND MANAGEMENT
Preferred email address of applicant:		gumedenl@eskom.co.za
If a Student	Your Degree: e.g., MSc, PhD, etc.	MSc Project Management
	Name of Supervisor (if supervised):	Ian Jay
If this is a research contract, indicate the source of funding/sponsorship		No
Project Title		A STUDY OF THE VALUE OF PROJECT STAGE-GATES WITHIN A NUCLEAR POWER UTILITY

I hereby undertake to carry out my research in such a way that:

- there is no apparent legal objection to the nature or the method of research; and
- the research will not compromise staff or students or the other responsibilities of the University;
- the stated objective will be achieved, and the findings will have a high degree of validity;
- limitations and alternative interpretations will be considered;
- the findings could be subject to peer review and publicly available; and
- I will comply with the conventions of copyright and avoid any practice that would constitute plagiarism.

SIGNED BY	Full name	Signature	Date
Principal Researcher/ Student/External applicant	NOMFUSI GUMEDE	Signed	10 Jun 2016

APPLICATION APPROVED BY	Full name	Signature	Date
Supervisor (where applicable)	IAN JAY		14/6/2016 Click here to enter a date.
HOD (or delegated nominee) Final authority for all applicants who have answered NO to all questions in Section1; and for all Undergraduateresearch (including Honours).	ABIMBOLA Wusango Click here to enter text.		28 July 2016 Click here to enter a date.
Chair : Faculty EIR Committee For applicants other than undergraduate students who have answered YES to any of the above questions.	Click here to enter text.		Click here to enter a date.

Page 1 of 1